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Case Report

CASE REPORT

Complications of an uncovered metallic tracheal stent managed by veno-venous extracorporeal membrane oxygenation: a case report

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Abstract

Airway stents are primarily inserted for the management of airway obstruction associated with an inoperable malignancy and are rarely indicated in benign disease. We outline the complications associated with tracheal stents and describe the use of veno-venous extracorporeal membrane oxygenation (V-V ECMO) to facilitate open tracheal surgery in an apnoeic patient who had an uncovered metallic tracheal stent left in place for an inappropriately long period. Computerised tomography imaging of the neck and thorax provided information for operative planning and described of the stent in addition to the extensive granulation tissue at the distal end of the stent. Veno-venous extracorporeal membrane oxygenation was used to facilitate open tracheal surgery, removal of the tracheal stent and formation of a surgical tracheostomy. Prolonged use of an uncovered metallic airway stent in younger patients with benign disease may lead to the stent being difficult to remove. There may be an accumulation of granulation tissue with the risk of airway obstruction.

Keywords: airway stent; airway surgery; difficult airway; ECMO; trachea

Abbreviations: ECMO Extra Corporeal Membrane Oxygenation; V-V ECMO Veno-venous extracorporeal membrane oxygenation

An airway stent is an endobronchial prosthesis that is used to maintain airway patency.[1] Airway stents are indicated for central airway obstruction owing to an expanding mass in the airway or extrinsic airway compression when there is no other surgical option available. Stents may also be used in the management of an airway fistula or after loss of cartilage support from tumour destruction.[2] Less commonly, insertion of an airway stent may be considered for benign stricture or stenosis, post-lung transplant airway stenosis, and complex benign stenosis >4 cm in length.[2,3] When airway stents are considered for benign disease in younger patients, uncovered metallic stents should rarely be used for prolonged periods and patients must be carefully followed up to assess for associated complications such as stent migration or granulation tissue formation.[4,5] In this case report, we describe the management of central airway obstruction due to excessive granulation tissue formation at the distal end of an uncovered metallic tracheal stent that was left in place for an inappropriately long period. The tracheal stent was found to be firmly embedded in the tracheal wall, and it was not possible to remove it during rigid bronchoscopy. Veno-venous extracorporeal membrane oxygenation (V-V ECMO) was used to facilitate open tracheal surgery, removal of the tracheal stent, and formation of a surgical tracheostomy. Informed written consent was obtained from the patient prior to writing and publication of this report, which was written following the CARE (CAse REports) publishing guidelines.

Case report

A 22-year-old male patient who had arrived in Ireland only two weeks previously presented to our emergency department

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with a 3-day history of worsening dyspnoea and stridor. Communication of exact dates and medical details was hampered by language difficulties, but his family informed us that he had been involved in a road traffic accident in his own country 2 years ago. He had suffered a traumatic injury to his larynx and upper trachea and a small cerebral haemorrhage. During his recovery, he required a tracheostomy, which was complicated by the development of sub-glottic tracheal stenosis.

On presentation to our emergency room, the patient was tachycardic, tachypnoeic, and unable to lie supine or complete full sentences. He also had an audible stridor. A flexible nasal endoscopy examination revealed that the proximal end of an uncovered metallic stent was protruding through the vocal cords. Our understanding at that time was that a tracheal stent had been inserted by an otolaryngologist in the patient's own country approximately two months previously for the management of the sub-glottic stenosis and that the stent had potentially become displaced in the days before arrival in our emergency department.

The patient was transferred to the operating room (out-of-hours) for rigid bronchoscopy under general anaesthesia. Before induction of general anaesthesia, an 18G intravenous cannula and 20G radial arterial line were inserted. The patient was preoxygenated (FiO_2 100% at 15 L min^{-1}) with a facemask for 5 min, and high-flow nasal oxygenation 35–70 L min^{-1} was applied. General anaesthesia was induced with 150 μg fentanyl (2 μg kg^{-1}), 150 mg propofol (2 mg kg^{-1}), and 75 mg rocuronium (1 mg kg^{-1}). Anaesthesia was maintained with propofol and remifentanil.

After induction of anaesthesia, a size 6 Storz rigid bronchoscope was inserted into the proximal end of the stent and venturi jet ventilation was attempted via the side port of the bronchoscope. Direct vision of the patient's airway through the rigid bronchoscope confirmed the stent was displaced proximally with extensive granulation tissue at the distal end of the stent (Fig 1). There were several attempts to extract the stent but this was abandoned after approximately 5 min because of unsatisfactory oxygenation and ventilation with jet ventilation (Fig 1 online video). The thoracic surgeon reported that the stent was tightly adherent to the tracheal wall. The rigid bronchoscope was removed and bag mask ventilation was attempted with difficulty. Tracheal intubation was successful on the third attempt using a McGrath video laryngoscope and a size 4 microlaryngoscopy tube (MLT).

Tracheal intubation was difficult because the proximally displaced stent was now deformed after attempted removal and because of the extensive granulation tissue at the distal end of the stent. The microlaryngoscopy tube was advanced through the stent and beyond the granulation tissue.

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An urgent CT scan of the patient's neck and thorax confirmed that the metallic stent extended from the level of the larynx to the upper border of the first thoracic vertebrae. A web of soft tissue extended 1.2 cm distal to the inferior end of the stent completely surrounding the endotracheal tube. The stent was embedded into the tracheal wall with the tip of the microlaryngoscopy tube advanced beyond the granulation tissue where the central airways were widely patent.

The following day and after a multidisciplinary team meeting, open tracheal surgery was planned to remove the embedded stent and resect the associated granulation tissue. At this stage, the patient's lungs had been ventilated for 18 hours with the microlaryngoscopy tube in place, and we were fully aware that we required a more definitive airway. Gas exchange could be achieved with V-V ECMO. If deployed before surgery, ECMO would enable us to discontinue mechanical ventilation and remove the microlaryngoscopy tube during the procedure. Using a full aseptic Seldinger technique, a 25 Fr multistage drainage ECMO cannula was advanced through the right femoral vein, and a 21 Fr single stage return cannula was advanced through the left femoral vein. A subcostal transthoracic echocardiogram showed that the distal tip of the drainage cannula was in the inferior vena cava and the tip of the return cannula was in the right atrium. A bolus of 5000 units of unfractionated heparin was administered to achieve an activated clotting time of 180 sec prior to cannulation. The initial ECMO blood flow was 3 L min^{-1} and the initial sweep gas flow was 3 L min^{-1} using 100% oxygen. The patient's trachea was extubated when on full V-V ECMO blood flow and the patient remained apnoeic with satisfactory oxygenation and carbon dioxide clearance during the procedure.

After a vertical midline incision through the tracheal rings down to 3 cm above the carina, the stent was successfully removed and the granulation tissue was resected. A size 6 Shiley tracheostomy tube was inserted by the attending

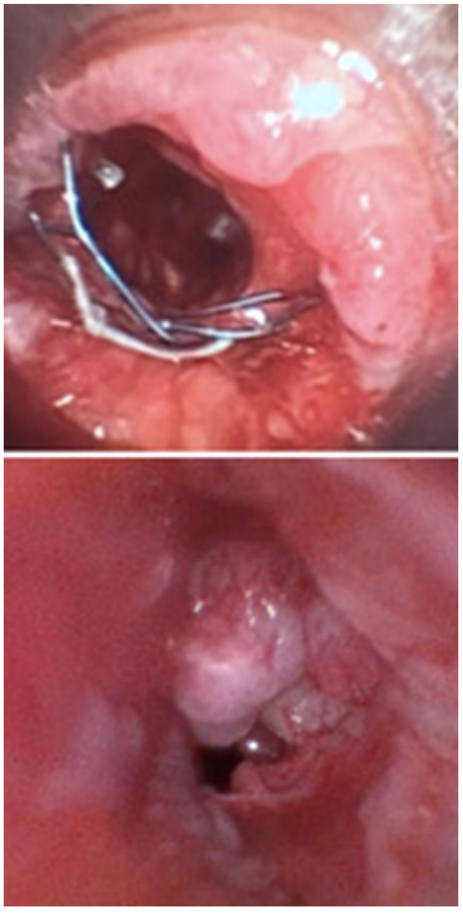

Fig. 1. View through the rigid bronchoscopy illustrating the metallic tracheal stent and excess granulation tissue.

otolaryngologist, and conventional mechanical ventilation was resumed. The patient was decannulated from ECMO following the procedure and transferred to the intensive care unit.

Discussion

The main indication for insertion of an airway stent is to manage impending central airway obstruction as a result of compression by an intra- or extra-tracheal mass when there are no other surgical options available.[1] If an airway stent is being considered for management of a benign process, an uncovered metallic stent is not recommended as first-line therapy and should only be used short term if all other options (silicone or hybrid stents) fail. In comparison with non-metallic airway stents (e.g. silicone), metallic stents are more easily inserted (via flexible bronchoscopy), have a larger internal-to-external diameter ratio, and are associated with a lower incidence of stent migration.[6] However, removal of uncovered metallic stents can be difficult if they have been in place for more than 30 days.[4,5]

Our patient had an uncovered metallic stent inserted for management of tracheal stenosis after a tracheal injury and prolonged tracheostomy. We had assumed that our patient's stent had been *recently* deployed and was now displaced up through the vocal cords, so that removal of the stent should have been possible using conventional surgical methods. The patient had presented with some degree of respiratory distress, and there was some urgency to proceed with the initial examination under anaesthesia. We were not surprised by the difficulty with tracheal intubation because of the displaced tracheal stent and potential residual tracheal stenosis. However, we did not anticipate that removing the stent would be so challenging. Prior to his eventual discharge from our hospital, we established that the stent had been in place for 18 months prior to his presentation to our emergency department.

Tracheal stents can be removed under general anaesthesia using a rigid bronchoscope. Jet ventilation through the rigid bronchoscope is usually successful in maintaining oxygenation and ventilation during these procedures. However, in our case, oxygenation and ventilation became increasingly difficult after only 5 min using this method. We believe that the combination of tracheal pathologies (displaced or deformed tracheal stent and the presence of granulation tissue at the distal end of the stent) contributed to the difficulty with jet ventilation. Jet ventilation may not have been as helpful as we had hoped because the extensive granulation tissue may have limited both inspiratory and expiratory airflow. On review of the CT images, it might have been technically possible to place a tracheostomy below the stent, but the presence of extensive distal granulation tissue could have made this a potentially hazardous procedure.

V-V ECMO is used in the management of critically ill patients with acute, severe, potentially reversible respiratory failure. It has also been used to facilitate complex thoracic surgery[7] and lung transplantation.[8] Malpas and colleagues[9] described the successful use of V-V ECMO for management of a difficult airway in a patient with severe tracheal deformity. Two important aspects of ECMO need to be emphasised. The use of heparin anticoagulation during ECMO may increase the risk of intraoperative bleeding. The aspiration of venous blood into the ECMO circuit under negative pressure may also lead to entrainment of air through a vein that is open to the atmosphere. Air could potentially de-prime the centrifugal pump and stop the ECMO blood flow.[9]

This symptomatic patient could have presented to a hospital without ECMO capability. Jet ventilation was poorly tolerated, and performing an emergency tracheosotmy could have been potentially hazardous. Advancing a microlaryngoscopy tube through the stent and distal to the granulation tissue proved feasible for short-term airway control. However, we urgently needed a plan to safely exchange the microlaryngoscopy tube for a more definitive airway.

V-V ECMO was chosen in our centre as we fortunately have access to equipment and expertise for this complex case. Contacting an ECMO centre can be informative (and invaluable if circumstances allow), and the patient could be transferred to an ECMO centre for further management.

Our case report highlights multiple learning points. Firstly, in a patient with a tracheal stent in place, medical and surgical history must be reviewed carefully to ensure that the treating surgeon and anaesthesiologist can prepare a comprehensive management plan. Specifically, direct communication with the clinician who placed the stent can be instructive. The indications for the stent, type of stent (non-metal *vs* metallic), and the duration since deployment are vital pieces of information.[4,5,10] Notably, if a metallic tracheal stent has been in place for longer than 30 days, it may be impossible to remove using a rigid bronchoscope. Secondly, preoperative imaging should be sought to identify the position of the stent and any associated complications (e.g. granulation tissue) and to guide the management plan. Thirdly, the treating anaesthesiologists should be aware that maintaining oxygenation and ventilation through a rigid bronchoscopy using jet ventilation may be difficult if granulation tissue partially occludes the distal airway. Fourthly, V-V ECMO provides satisfactory gas exchange in an apnoeic patient allowing removal of the endotracheal tube to facilitate complex tracheobronchial surgical intervention. Therefore, we suggest that V-V ECMO should be considered when managing patients with complex tracheal stents which may require surgical intervention.

Authors' contributions

Compilation of the first draft: MH.
Liaison with fellow authors: MH.
Assistance in preparation of first draft of the manuscript: AM.
Obtainment of patient consent: AM.
Review of manuscript, from first to final drafts, providing suggestions to improve the text: HF, EC.
Review of manuscript from surgical viewpoint, providing invaluable content to aid editing: DE.
Editing of the manuscript: MH, EC.
Editing of various drafts of the manuscript: MG, EC.
Provided images: BR.
Revision of the manuscript: MH, BR, EC.

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Declaration of interest

The authors declare that they have no conflicts of interest.

References

1. Ernst A, Silvestri GA, Johnstone D. Interventional pulmonary procedures: guidelines from the American college of chest physicians. *Chest* 2003; **123**: 1693–717
2. Folch E, Keyes C. Airway stents. *Ann Cardiothorac Surg* 2018; **7**: 273–83
3. Barros Casas D, Fernandez-Bussy S, Folch E, Flandes Aldeyturriaga J, Majid A. Non-malignant central airway obstruction. *Arch Bronconeumol* 2014; **50**: 345–54
4. Lunn W, Feller-Kopman D, Wahidi M, Ashiku S, Thurer R, Ernst A. Endoscopic removal of metallic airway stents. *Chest* 2005; **127**: 2106–12
5. Alazemi S, Lunn W, Majid A, et al. Outcomes, health-care resources use, and costs of endoscopic removal of metallic airway stents. *Chest* 2010; **138**: 350–6
6. Saad CP, Murthy S, Krizmanich G, Mehta AC. Self-expandable metallic airway stents and flexible bronchoscopy: long-term outcomes analysis. *Chest* 2003; **124**: 1993–9
7. Zhang Y, Luo M, Wang B, Qin Z, Zhou R. Perioperative, protective use of extracorporeal membrane oxygenation in complex thoracic surgery. *Perfusion* 2021 April 28. https://doi.org/10.1177/02676591211011044 (online ahead of print)
8. Hayanga JWA, Chan EG, Musgrove K, Leung A, Shigemura N, Hayanga HK. Extracorporeal membrane oxygenation in the perioperative care of the lung transplant patient. *Semin Cardiothorac Vasc Anesth* 2020; **24**: 45–53
9. Malpas G, Hung O, Gilchrist A, et al. The use of extracorporeal membrane oxygenation in the anticipated difficult airway: a case report and systematic review. *Can J Anaesth* 2018; **65**: 685–97
10. Murgu S, Stoy S. The when, the how and the why of metallic stent removal. *J Bronchol Interv Pulmonol* 2016; **23**: 266–71