Two-Stage Technique Used to Manage Severe Upper Airway Obstruction and Avoid Surgical Tracheostomy: A Case Report

Desire N. Onwochei, MBBS, BSc (Hons), FRCA, MSc,
Kariem El-Boghdadly, MBBS, BSc (Hons), FRCA, EDRA, MSc, and Imran Ahmad, MBBS, FRCA

Severe upper airway obstruction is commonly managed with surgical tracheostomy under local anesthesia. We present a 49-year-old woman with postradiotherapy laryngeal fixation and transglottic stenosis for dilation of a pharyngeal stricture who refused elective tracheostomy. A 2-stage technique was used, which involved an awake fiberoptic intubation, followed by the transtracheal insertion of a Cricath needle and ventilation using an ejector-based Ventrain device. We discuss management aspects of this clinical scenario and the principles by which the Ventrain works. (A&A Practice. 2018;10:118–20.)

Surgical tracheostomy under local anesthesia is a well-known method of securing the airway in patients with critical obstruction,[1] avoiding the need for manipulation, which could lead to airway loss, hypoxia, and death. However, tracheostomies are not without complications[2] and patients may be reluctant to have them performed electively.

We present a case of a patient with severe upper airway obstruction undergoing surgical intervention, avoiding the need for tracheostomy by using a 2-stage airway management technique. Written informed consent was obtained from the patient for publication of this report, which has been structured according to the Case Report guidelines.[3] The authors of this report were directly involved in the perioperative care of this patient.

CASE DESCRIPTION

A 49-year-old woman (height, 167 cm; weight, 53 kg) with laryngeal fixation secondary to radiotherapy presented for dilation of a C5 pharyngeal stricture. Her surgical history included 2 tracheostomies, 1 emergent for failed intubation, and radiotherapy for an infratemporal fossa paraganglioma. Previous videolaryngoscopy with an AP Advance (APA; Venner Medical International, Jersey, United Kingdom) achieved a Cormack–Lehane grade III view, although the blade type was undocumented in her notes, and she had undergone awake fiberoptic intubations (AFOIs) in the past. She could only walk short distances and had been hospitalized for 2 weeks before receiving treatment for a chest infection, remaining an inpatient until she was well enough for surgery. She had a hoarse voice and audible stridor, a hardened anterior neck with significantly reduced extension (thyromental distance <6 cm), a deviated tongue and jaw with minimal protrusion of both, and a Mallampati of IV. Oxygen saturation was 96% on air.

The patient sternly refused an awake elective tracheostomy or wide-bore cricothyroid cannula, so a 2-stage airway management technique was performed: an AFOI with a small diameter endotracheal tube, followed by needle cricothyroidotomy after anesthetic induction, to which the patient had consented. Virtual endoscopy had been performed preoperatively using OsiriX Viewer v5.5 32-Bit (Pixmeo Sari, Bernex, Switzerland)[4] to provide the dimensions of the glottis and determine the feasibility of AFOI. High-flow, heated, humidified oxygen was applied at 50 L·minute^{-1} via nasal cannulae using Optiflow (Fisher & Paykel Healthcare, Auckland, New Zealand). Invasive arterial blood pressure monitoring was established in the right radial artery. After local anesthetic topicalization and sedation with target-controlled infusions of propofol and remifentanil, a fiberoptic scope was passed via the right nostril. A large anterior granulomatous lesion was seen arising from the left laryngeal ventricle (Figure 1). A size 5.0-mm internal diameter microlaryngeal tube (MLT, Portex Blue line; Smiths Medical International Limited, Kent, United Kingdom) was successfully introduced into the trachea. Propofol and remifentanil target-controlled infusion were then increased to induce anesthesia, and atracurium 1 mg·kg^{-1} was administered. The best view obtained with direct laryngoscopy and size 3 Macintosh blade after AFOI and anesthetic induction was a Cormack–Lehane grade III. Rigid bronchoscopy also proved impossible because of poor neck extension and in situ MLT, resulting in accidental fracture of a calcified stylohyoid ligament. Front-of-neck ultrasound revealed an easily accessible cricothyroid membrane. Under sterile conditions, a sharp 22-gauge guide needle was used to pierce the membrane, as is our usual practice, and was particularly helpful because of the thickened fibrotic tissues. Needle cricothyroidotomy was then performed using a Cricath needle for the Ventrain (Ventinova Medical BV, Eindhoven, the Netherlands) under direct bronchoscopic vision via the MLT (Figure 2; Supplemental Digital Content, Video 1, http://links.lww.com/AACR/A133). The Ventrain was connected to 100% oxygen via a flowmeter at

VIDEO+

From the Department of Anesthesia, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom.

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Address correspondence to Desire N. Onwochei, MBBS, BSc (Hons), FRCA, MSc, Department of Anesthesia, Guy's and St Thomas' NHS Foundation Trust, Guy's Hospital, Great Maze Pond, London SE1 9RT, United Kingdom. Address e-mail to desire@doctors.org.uk.

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15 L·minute^{-1}. Ventilation was undertaken at 12–16 breaths per minute, with an inspiratory:expiratory ratio of 1:2. Capnography was attached to the Luer connector on the Ventrain tubing and the MLT was removed to aid surgical access. The fractured stylohyoid ligament allowed the rigid bronchoscope to be adequately inserted. The granulomatous lesion was then accessible for biopsy and debulking, and the pharyngeal stricture was dilated under radiologic guidance. Ventilation was maintained for 75 minutes and arterial carbon dioxide was 46 mm Hg at the end of the procedure. We did not observe any air leak or complete airway obstruction during ventilation, and there was no obstruction of the tubing with blood or secretions. Oxygen saturation remained 100% throughout. The patient was transferred to the intensive care unit fully alert, with the Cricath in situ. This was removed 24 hours postoperatively, and the patient suffered no airway compromise or complications, only the hoarse voice persisted. She was discharged home 2 days later.

DISCUSSION

Tracheostomy, whether emergent or elective, is associated with short- and long-term complications, such as hemorrhage or tracheal stenosis.[2] Patient refusal for elective tracheostomy is not uncommon, and alternative means of safe airway management may need to be sought.

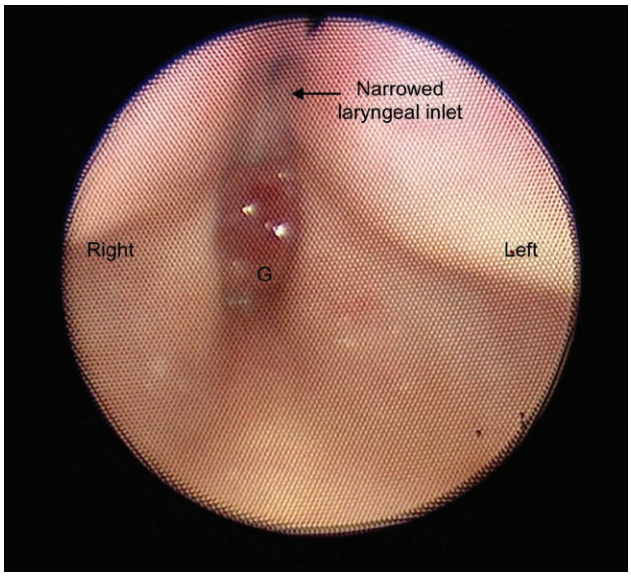

Figure 1. Narrow laryngeal inlet and large anterior granulomatous lesion (G) arising from the left laryngeal ventricle, seen on flexible bronchoscopy.

This case demonstrates a 2-stage technique for the management of an obstructed upper airway using the Ventrain. Other approaches considered were transnasal humidified rapid-insufflation ventilatory exchange or high-frequency jet ventilation (HFJV). However, these alternatives require unobstructed expiration, which was not the case in our patient. Moreover, if either technique had failed and bag-mask or laryngeal mask ventilation was not achievable, the safest rescue intervention would have been an emergency surgical tracheostomy, which the patient adamantly refused. Transglottic HFJV requires laryngoscopy to pass a jet catheter into the trachea, which would have proved difficult and potentially dangerous in the presence of the known difficult airway and the risk of causing oral cavity damage. Breath stacking and barotrauma are also risks of HFJV, compounded, in this case, by a lack of upper airway patency.[5] Rigid bronchoscopy had already proved impossible; therefore, ventilation via this route was not an option in an unsecured airway. Awake Cricath insertion was also considered; however, the patient refused this. Awake videolaryngoscopy use was precluded by the reduced neck mobility, postradiotherapy fibrosis, and previous failure. AFOI is a common technique in our institution[6] and in this case, represented a procedure that was familiar and deemed safe in our hands. As surgery was not possible with an MLT in situ, the 2-stage technique was an amenable solution.

The Ventrain is a single-use, portable, flow-regulated, manually operated, ergonomically shaped ventilation device.[7] The accompanying Cricath needle has a 2-mm internal diameter and is 70 mm in length. It uses the Bernoulli principle to generate suction, which actively induces expiration, coined expiratory ventilation assistance.[7] This gives it an advantage over jet ventilation as not only is a patent upper airway not required but an obstructed airway actually improves oxygenation and carbon dioxide removal.[8] Furthermore, despite the device using a high-pressure oxygen source, the peak airway pressures are much lower than those generated with the Manujet III (VBM; Sulz a. N., Germany), 110 mbar vs. 1.5–3.0 bars, respectively.[8] In unobstructed airways, the efficiency of expiratory ventilation assistance is reduced; however, the lower peak airway pressures still offer an advantage over jet ventilation.[7,9] Reports have described achieving oxygenation and adequate ventilation with the Ventrain for 6 minutes in pigs[9] and 20 minutes in a human patient with a partially obstructed airway.[10] The Ventrain has also been used for up to 130 minutes in combination with a novel small diameter endotracheal tube.[11]

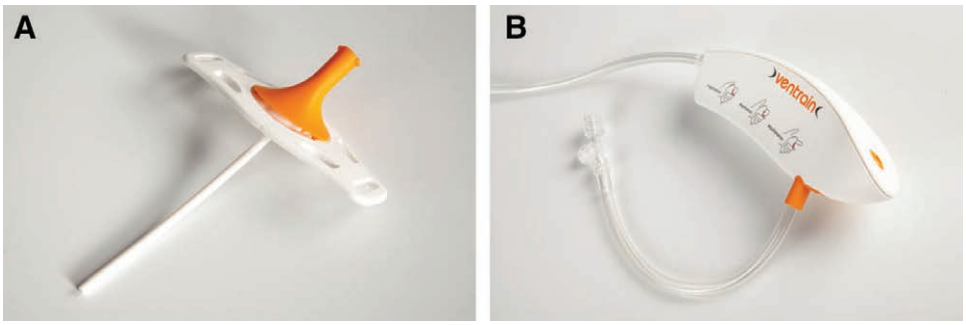

Figure 2. Needle cricothyroidotomy kit. A, Cricath needle. B, Ventrain device.

We have demonstrated its use for a duration of 75 minutes, in a severely obstructed airway, which is, to our knowledge, the longest documented time frame for successful ventilation using the Cricath needle with this device. However, we were not able to measure peak airway pressures during this period. A similar 2-stage technique has previously been reported in a patient who was amenable to both wide-bore cannula cricothyroidotomy and tracheostomy, where suspension laryngoscopy allowed full glottic access.[12] This context varies from our current report in clinical urgency, alternative technical options, and the degree of risk. The novelty of this case therefore supports the use of Ventrain as a backup or as a primary technique, regardless of the acuity of the case.

The Ventrain does have some limitations, namely, reduced efficacy in unobstructed airways. Additionally, hyperinflation and excessive negative intrathoracic pressures can be produced, with the potential to cause negative pressure pulmonary edema in a completely obstructed airway. High pressures can be remedied by adjusting the inspiratory:expiratory ratio or allowing equilibration by removing the thumb and index finger from the exhaust and bypass apertures.

We have demonstrated a successful 2-stage technique for managing a patient with a severely obstructed upper airway, avoiding tracheostomy. At no point did airway compromise occur, and full airway control was maintained throughout; however, complete obstruction during AFOI and potential loss of airway during tracheal tube removal for cricothyroid puncture are important risks to keep in mind. Training in Ventrain use would be invaluable, as it is a viable alternative ventilation technique in complex airway management.

DISCLOSURES

Name: Desire N. Onwochei, MBBS, BSc (Hons), FRCA, MSc.
Contribution: This author helped with patient consent, and prepare and revise the manuscript.
Name: Kariem El-Boghdadly, MBBS, BSc (Hons), FRCA, EDRA, MSc.
Contribution: This author helped revise the manuscript and prepare the images.
Name: Imran Ahmad, MBBS, FRCA.
Contribution: This author helped revise the manuscript and prepare the supplemental video.
This manuscript was handled by: Hans-Joachim Priebe, MD, FRCA, FCAI.

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