Difficult airways: a reliable "Plan B"

Bishop DG, MBChB, DA(SA), FCA(SA); **Farina Z**, MBChB, DA(SA), FCA(SA)
Wise RD, MBChB, Dip Obst(SA), Dip PEC(SA), FCA(SA)
Pietermaritzburg Metropolitan Department of Anaesthesia, Critical Care and Pain Management, University of KwaZulu-Natal
Correspondence to: David Bishop, e-mail: davidgbishop@gmail.com
Keywords: difficult airway, percutaneous jet ventilation, rescue ventilation

Abstract

Percutaneous transtracheal jet ventilation (PTJV) is an accepted method of rescue ventilation following unsuccessful attempts to secure the airway through conventional methods. Pre-emptive use of PTJV in the difficult airway has also been described as using either a specifically designed jet ventilation catheter, or other cannulae, such as a central venous catheter (CVC). We report on the insertion of a single-lumen CVC to establish a means for PTJV or oxygen insufflation prior to induction of general anaesthesia in an 18-year-old man. He had an anticipated difficult airway and potentially difficult rescue airway access, having been booked for biopsy of neck masses and formal tracheostomy.

Ⓟ **Peer reviewed. (Submitted: 2010-11-15, Accepted: 2011-03-04)** **S Afr J Anaesth Analg 2011;17(2):186-189**

Introduction

In the management of the difficult airway, an alternative method of maintaining oxygenation should be considered where laryngoscopy, mask ventilation and/or rescue with a supraglottic airway (SGA) or cricothyroidotomy is anticipated to be difficult. We describe the transtracheal placement of a central venous catheter (CVC) as a means to establish rescue jet ventilation in a patient with a difficult airway who was unwilling to undergo a tracheostomy under local anaesthesia. The awake placement of the rescue device, as our "Plan B", enabled us to proceed confidently with the induction of general anaesthesia, with the knowledge that an inability to mask ventilate or intubate our patient could be managed through jet ventilation.

Case report

An 18-year-old male, with a five-month history of progressive neck swelling, was booked by the ear, nose and throat (ENT) surgeons for a tracheostomy and biopsy of the neck masses. Previous biopsies under local anaesthetic had been inconclusive. The patient gave a history of recent voice changes and respiratory obstruction, which occurred mainly at night and in the supine position, but which were not present while he was awake and upright.

Clinical examination revealed an alert, co-operative man, with mild inspiratory stridor, and complete nasal obstruction caused by a tumour. Airway assessment showed limited mouth opening (2 cm), drooling and a Mallampati score of four. The cricothyroid membrane was easily palpable in the midline, despite massive lymphadenopathy. This finding was supported by the accompanying sagittal section of his computed tomography (CT) scan, illustrating accessibility of the airway via the cricothyroid membrane (see Figure 1). In cases where a CT scan has not been requested, an appropriate investigation is a lateral neck X-ray with soft-tissue penetration. This would provide the same information

Figure 1: CT scan illustrating suitable anatomy for airway cannulation in the midline

at a much lower cost, involve less radiation exposure, and would be particularly appropriate in a resource-constrained setting.

The patient was assessed as potentially difficult to mask ventilate with anticipated difficult laryngoscopy, but with a reasonable chance of success using rescue ventilation through a surgical airway. The clinical impression was that an SGA may have had difficulty seating due to the distortion of the upper airway and lateral pharyngeal walls by the lymphadenopathy. The patient was reluctant to undergo a tracheostomy under local anaesthesia. Since the invasiveness of an awake oral fibre-optic intubation approaches that of tracheostomy under local anaesthesic, we thought it unlikely that we could persuade the patient to accept this route.

We elected to insert a single-lumen, 16-G CVC through the cricothyroid membrane while the patient was awake. Under aseptic conditions, 2% lignocaine was infiltrated to the area. An 18-G intravenous cannula was inserted through the cricothyroid membrane, and placement of the cannula confirmed with aspiration of air once the needle had been removed. With the aid of the cannula, a conventional Seldinger technique was used to insert the CVC. The catheter was secured to the skin at 6 cm and sutured into place, as illustrated (see Figure 2). Correct placement was confirmed with aspiration of air and capnography. The jet ventilator was not used prior to induction of anaesthesia.

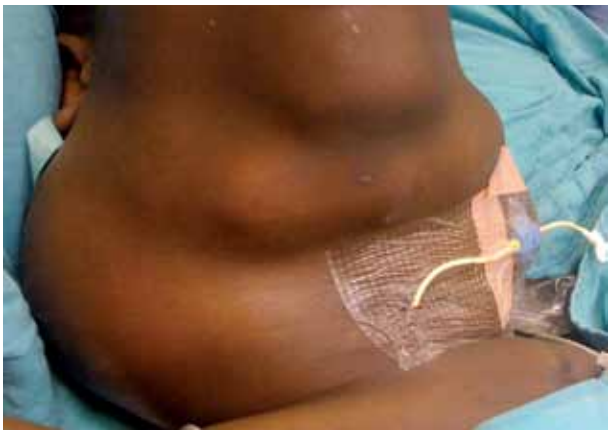

Figure 2: Single-lumen CVC in place prior to induction of anaesthesia

Anaesthesia was then commenced with a gas induction using sevoflurane. There was no airway obstruction during induction, and laryngoscopy revealed a Cormack and Lehane grade II view. The patient was intubated with a size 6.0 armoured endotracheal tube. No muscle relaxants were required, and we did not need to jet ventilate during the procedure. The CVC was then withdrawn and the ENT surgeons proceeded with an uneventful tracheostomy (see Figure 3) and biopsies. The histology revealed a poorly differentiated nasopharyngeal carcinoma, and the patient was booked for follow-up at oncology.

Figure 3: Tracheostomy in situ in the recovery room

Discussion

In 1956, Jacoby et al described the use of transtracheal oxygen insufflation, via a 14-G needle, as a bridge to securing a definitive airway.[1] In 1971, Spoeral et al then demonstrated the efficacy of transtracheal high-pressure jet ventilation.[2] In 1999, percutaneous transtracheal jet ventilation (PTJV) was reviewed by Patel as a safe and quick way to achieve temporary oxygenation and ventilation, following the failure of conventional methods.[3] Patel used a commercially available 12-G venous access device [inner diameter (ID) 2.8 mm)], or a special transtracheal catheter (6 F, ID 2 mm), and expressed concern that regular catheters are thin-walled and kink easily. The use of a CVC to establish translaryngeal jet ventilation was first described in children,[4] and the use of the CVC has subsequently been described to establish transtracheal jet ventilation.[5] The CVC is less likely to kink or become displaced, and is easily secured. The ability to secure the cannula adequately is vital to prevent the potentially disastrous complications associated with jet ventilation through a displaced cannula. The use of a single port is advantageous because it is cheaper, and reduces potential user error by preventing PTJV through a proximal port which may not be in the lumen of the airway. A disadvantage is the inability to monitor CO_2 continuously, although capnography can still be used to confirm placement prior to the use of the jet ventilator. We believe that the smaller lumen of a double-lumen CVC is unlikely to facilitate effective gas escape, a purported advantage of the double-lumen. In deciding on size, Yealy et al suggest that size 16-G, or bigger cannula should be used for jet ventilation.[6]

One of the concerns with this technique is that complete airway obstruction is considered to be a contraindication to PTJV.[3] In the setting where this is likely, the CVC could be used to insufflate oxygen in the same manner as a needle cricothyroidotomy, rather than to ventilate. A potential benefit of this technique is that PTJV may make laryngoscopy easier. Patel asserted that the high-pressure gas insufflation may open a collapsed glottis, while Chandradeva et al described the phenomenon of "glottic flutter" in oedematous airways, which makes identifying landmarks easier.[7] In a letter responding to Chandradeva's case report, McLeod et al suggested that an automated jet ventilator with end-expiratory pressure monitoring linked to a pause function would enhance their technique, and minimise the risk of barotrauma in the potentially obstructed airway.[8] A concern in complete supraglottic obstruction is that barotrauma becomes very likely in the event of PTJV, or oxygen insufflation techniques.

The risk of barotrauma with the use of PTJV is certainly a valid concern, and is yet to be quantified precisely. Various suggestions have been made to minimise this risk. An inflation pressure of less than 4 bar (58 psi) is thought to make the risk of barotrauma less likely.[9] Some authors have proposed pressure monitoring through an additional port in the CVC, but expressed concern over the length of catheter which would need to remain in the trachea, and the possibility of "whipping" of the catheter inside the trachea.[10] Theoretically, this could lead to airway trauma. The use of a dedicated jet ventilator with a pause pressure alarm facility, as suggested by McLeod et al,[8] is possibly the best available method to reduce the incidence of barotrauma.

A key aspect of this technique is the correct placement of the cannula, through which the guidewire must be passed. Correct positioning is confirmed with aspiration of air, as well as capnography in both the cannula and the secured CVC. While this ensures that the CVC is within the lumen of the trachea, it does not confirm whether the catheter is directed in a cephalad or caudal direction. Cephalad positioning may occur in up to 20% of catheterisation attempts, and has obvious consequences in terms of the ability to oxygenate and jet ventilate through the catheter.[11,12] The cephalad positioning is thought to result from kinking of the cannula, and usually occurs when the cannula is being advanced off the needle into the lumen of the airway. Higgs and Vijayanand described a modification to the technique that we used, which may prevent this complication.[13] They suggested that once the position of the needle is confirmed with aspiration of air, the guidewire of the CVC should be advanced about 5 cm past the needle tip into the lumen. The cannula is then railroaded over the needle into the airway, and the needle withdrawn. The guidewire merely acts to direct the cannula caudally once it has entered the airway, and the position of the cannula is then confirmed with aspiration of air. While this technique describes the placement of a specifically designed transtracheal catheter, it should perhaps also be applied to the insertion of the CVC in order to minimise the risk of kinking.

In retrospect, it is interesting to note that despite the presence of several risk factors for difficult laryngoscopy, intubation was ultimately achieved relatively easily. Our patient had a Mallampati score of 4, yet his laryngoscopy revealed a grade II Cormack and Lehane view. This finding confirms the limited value of isolated clinical predictors such as the Mallampati score. In a recent meta-analysis, Lee et al investigated the accuracy of the Mallampati tests to predict a difficult laryngoscopy.[14] A large variation in inter-observer reliability was reported, and the accuracy of the test was described as ranging from "poor to good". Lee concluded that, in isolation, the Mallampati score is insufficient to predict the presence or absence of a difficult laryngoscopy, and they recommended that it should form only a limited part of the overall assessment of the airway. This is in line with the recommendations of the American Society of Anesthesiologists' task force on management of the difficult airway, which suggest that 10 other features, including dentition, thyromental distance and neck extension, should also be assessed.[15]

The CVC for PTJV was not required in this case, which raises the question of whether there was an alternative approach to the management of our patient's airway. Our first choice would have been to proceed with an awake technique in a patient with a potentially difficult mask ventilation and laryngoscopy. However, the patient was extremely reluctant to undergo an awake tracheostomy, and would have been unlikely to cooperate fully during the procedure. In the opinion of the anaesthesiologists involved, an awake fibre-optic intubation would have been difficult in the absence of sufficient mouth opening, the presence of excessive salivation, and the problems of obligatory mouth breathing in a shared airway. An awake nasal fibre-optic intubation was not an option due to complete obstruction of the nasal passages by a tumour. SGAs, in particular the intubating laryngeal mask (iLMA), have provided a very useful alternative in the patient with difficult laryngoscopy. Of concern in this patient was the distortion of upper airway structures secondary to the lymphadenopathy. The iLMA needs to be positioned accurately in order to guide the endotracheal tube into the trachea. We would suggest that if an iLMA is chosen as a route to intubation in this scenario, the endotracheal tube be guided out of the iLMA

with a fibre-optic bronchoscope, as recommended by the Difficult Airway Society in a situation of unanticipated difficult laryngoscopy.[16]

In view of the successful outcome of this case, the risk of a cricothyroid puncture appears to be justified, given that rescue ventilation in an obstructed and potentially desaturating patient is never easy, and time pressure may well have led to fatal error. There is adequate precedent for the method chosen, which in some institutions is considered both standard[17] and routine.[18] This report demonstrates that pre-induction insertion of a CVC, for use as a conduit for oxygenation during anaesthetic induction in the event of airway obstruction, is an appropriate alternative in the patient in whom an awake technique would be preferable, but in whom an absolute or relative contraindication is present, and where a reliable Plan B would be desirable.

References

1. Jacoby JJ, Hamelberg W, Ziegler CH, et al. Transtracheal resuscitation. JAMA. 1956;162:625-628.
2. Spoerel WE, Narayanan PS, Singh NP. Transtracheal ventilation. Br J Anaesth. 1971;43:932–939.
3. Patel RG. Percutaneous transtracheal jet ventilation: a safe, quick, and temporary way to provide oxygenation and ventilation when conventional methods are unsuccessful. Chest. 1999;116:1689-1694.
4. Dhara SS, Butler PJ. High frequency jet ventilation for microlaryngeal laser surgery. An improved technique. Anaesthesia. 1992;47:421-424.
5. Seung-Ho C, et al. Transtracheal high-frequency jet ventilation using a two-lumen central venous catheter for laryngomicrosurgery. Korean J Anesthesiol. 2008;54:S40-S42.
6. Yealy DM, Stewart RD, Kaplan RM. Myths and pitfalls in emergency translaryngeal ventilation: correcting misimpressions. Ann Emerg Med. 1988;17:690-692.
7. Chandradeva K, Palin C, Ghosh SM, Pinches SC. Percutaneous transtracheal jet ventilation as a guide to tracheal intubation in severe upper airway obstruction from supraglottic oedema. Br J Anaesth. 2005;94:683-686.
8. McLeod ADM, Turner MWH, Torlot KJ. Safety of transtracheal jet ventilation in upper airway obstruction. Br J Anaesth. 2005;95:560-561.
9. Benumof JL, Gaughan SD. Concerns regarding barotrauma during jet ventilation. Anesthesiology. 1992;76:1072-1073.
10. Dhara SS, Liu EHC, Tan KHS. Monitored transtracheal jet ventilation using a triple lumen central venous catheter. Anaesthesia. 2002;57:578-581.
11 Sdrales I, Benumof JL. Prevention of kinking of a percutaneous transtracheal intravenous catheter. Anesthesiology. 1995;82:288-291.
12 McGuire BE. Emergency airway access equipment. Anaesthesia. 2004;59:1029-1030.
13. Higgs A, Vijayanand P. Prophylactic percutaneous transtracheal catheterisation. Anaesthesia. 2005;60:237-1252.
14. Lee A, Fan LTY, Gin T, et al. A systematic review (meta-analysis) of the accuracy of the Mallampati tests to predict the difficult airway. Anesth Analg. 2006;102:1867-1878.
15. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists' task force on management of the difficult airway. Anaesthesiology. 2003;98:1269-1277.
16. Henderson JJ, Popat MT, Latto IP, Pearce AC. Difficult Airway Society. Difficult Airway Society guidelines for management of the unanticipated difficult intubation. Anaesthesia. 2004;59(7):675-694.
17. Gerig HJ, Schnider T, Heidegger T. Prophylactic percutaneous transtracheal catheterisation in the management of patients with anticipated difficult airways: a case series. Anaesthesia. 2005;60(8):801-805.
18. Patel C, Diba A. Measuring tracheal airway pressures during transtracheal jet ventilation: an observational study. Anaesthesia. 2004;59:248-251.