CASE REPORT

Emergency percutaneous transtracheal jet ventilation in a hypoxic cardiopulmonary resuscitation setting: a life-saving rescue technique

Phi-Vu Dong,¹ Leontien ter Horst,¹ Ralf Krage²

¹Department of Anaesthesiology, Catharina Hospital, Eindhoven, The Netherlands

²Department of Anaesthesiology, VU University Medical Centre, Amsterdam, The Netherlands

Correspondence to

Phi-Vu Dong,
phivu.dong@
catharinaziekenhuis.nl

Accepted 9 January 2018

SUMMARY

(Un)anticipated difficult airway remains a challenge in anaesthesia. Percutaneous transtracheal jet ventilation has been shown to be an adequate technique for temporary oxygenation and ventilation and has been described as an acknowledged method in emergency settings of an unanticipated difficult airway. These emergency settings can be considered as low incidence high-risk situations. Both technical and non-technical skills should be trained regularly as education and simulation continues to play an important factor in patient safety. Furthermore, postoperative laryngeal oedema due to altered lymphatic drainage patterns must be considered as a possible mechanism of an upper airway obstruction in combination with a history of neck dissection and radiotherapy.

minor invasive procedure, in line with the local and national guidelines on ENT procedures.

On the day of surgery an awake fibre-optic nasal intubation, due to a restricted mouth opening, was started under sedation with remifentanyl with an uncomplicated placement of a 7.0 mm endotracheal tube (ETT) and general anaesthesia was maintained with intravenous propofol and remifentanyl. During the procedure, two small biopsies were taken; intraorally at the tongue base and externally at a scar on the neck. After a short 20 min surgery, the patient was extubated successfully after regaining full consciousness. Standard monitoring, including pulse oximetry, non-invasive blood pressure measurements and ECG, showed stable clinical conditions. One hour after admission to the Post Anaesthesia Care Unit (PACU), the patient had difficulties in breathing and the anaesthesiologist was informed.

BACKGROUND

Efficient airway management is a key factor for safety in anaesthesia, but can be challenging in the perioperative setting. Despite a recent review on a ear, nose and throat (ENT) population, with no emergency surgical airway needed in the perioperative setting.¹ Cook *et al* found an incidence of 1:22 000 major complications in airway management of which 39% were ENT related.² They concluded that the incidence of airway-related complications is low; however if complications do occur, they are often serious. In this case, we describe a hypoxic cardiopulmonary resuscitation (CPR) due to a supraglottic obstruction, in which we performed emergency percutaneous transtracheal jet ventilation (PTJV) as a temporary rescue technique for initiating and maintaining oxygenation and ventilation.

CASE PRESENTATION

A 62-year-old woman was planned for an elective panendoscopy. Since 2010, she suffered from malignancies of the oral cavity and the oropharynx with multiple surgeries including a combined mandibulectomy and a bilateral lymph node dissection of the neck with radiotherapy. Her medical history includes an aortic mechanical valve replacement 8 years ago. A recent cardiac check-up did not reveal any ischaemic heart diseases and good cardiac functions. Pre-existing relevant medications included acenocoumarol. There were no known allergies. Acenocoumarol was continued due to the

INVESTIGATIONS

On examination the patient had a markedly red face with a rash on the upper part of the thorax. Beside this, the patient was progressively dyspnoeic but still conscious with an inspiratory stridor. There were clear signs of respiratory distress with a tachypnoea of 25/min and an oxygen saturation of 95% with 15 L of oxygen. Other vital parameters included a heart rate of 103 beats per minute (bpm) and a blood pressure of 180/90 mm Hg.

DIFFERENTIAL DIAGNOSIS

Several causes of the upper airway obstruction are possible. An upper airway obstruction due to postoperative haemorrhage was unlikely due to lacking of evident exterior tissue swelling and because of the very small biopsies. An allergic reaction on the antibiotic prophylaxis (amoxicillin) or on one of the intravenous medication administered during the surgical procedure is also conceivable. However, the patient did receive the same medication multiple times in the past without any problems and presented only very local symptoms (stridor and rash). Furthermore, the vital parameters of heart rate and blood pressure make an anaphylactic reaction very unlikely.

Laryngeal oedema in association with a neck dissection may be an explanation in our case. Burkle *et al* presented a case report of a patient undergoing liver surgery with postoperative laryngeal

To cite: Dong P-V, ter Horst L, Krage R. *BMJ Case Rep* Published Online First: [please include Day Month Year]. doi:10.1136/bcr-2017-222283

Figure 1 Photograph of patient's neck; severely fibrotic tissue after multiple surgeries and radiation therapy.

obstruction.³ This patient was described with a history of a bilateral neck dissection and radiation therapy because of squamous cell carcinoma of the tongue 10 years earlier. On the recovery, she required a rescue airway technique because of laryngeal and pharyngeal swelling. A possible explanation for the acute respiratory obstruction was tissue swelling due to oedema after tube placement in combination with altered lymphatic drainage patterns because of the neck dissection and diminishes flexibility of tissues after radiation therapy. Another case report stated the same mechanism as the cause of an upper airway obstruction in which also an emergency cricothyroidotomy was required to handle the difficult airway.⁴ Our patient also had radiation therapy and neck dissection in her medical history, so this combination could be an explanation for the postoperative airway obstruction as well.

TREATMENT

Nebuliser therapy with ipratropium bromide and salbutamol was initiated without satisfactory improvement and a second, high urgency call was made to the anaesthesiologist. Nebuliser therapy with epinephrine was initiated and the ENT surgeon was called with high urgency. Due to a rapid respiratory deterioration, the decision was made to return to the operating theatre for performing an emergency tracheostomy. On arrival in the theatre, she was deeply cyanotic and lost consciousness. The monitor revealed a bradycardia of 30 bpm. CPR was initiated with chest compressions. Bag-mask ventilation was inadequate due the airway obstruction and the severely fibrotic musculature of the neck after multiple radiation therapies (figure 1). On fibre-optic endoscopy, an oedematous and swollen oropharynx and hypopharynx were found and no airway or anatomical landmarks were recognisable. Therefore, a needle cricothyroidotomy was performed which was challenging due to severe fibrotic musculature and absence of anatomic landmarks. A classical cricothyroidotomy was initially considered but subsequently discarded because of possible bleeding complications due to the continued therapy of acenocoumarol. The first attempt by the ENT surgeon with a regular intravenous catheter was inadequate. On the second attempt by the anaesthesiologist, a jet ventilation catheter was inserted successfully and PTJV could be started. After a total CPR time of 6–8 min and 1 mg of epinephrine, interrupted briefly several times to allow attempts of needle cricothyroidotomy, return of spontaneous

Figure 2 Postresuscitation chest X-ray with multiple signs of barotrauma; 1 day postresuscitation with a clear configuration of a pneumopericardium and subcutaneous emphysema.

circulation was achieved. Adequate oxygenation and ventilation was reconfirmed by the arterial blood gas analysis: pH 7.13, P_{CO_2} (partial pressure of carbon dioxide) 63 mm Hg, P_{O_2} (partial pressure of oxygen) 577 mm Hg. A secured airway was established through nasal fibre-optic intubation with a 6.0 mm ETT, guided by the bubbles created by the PTJV. After stabilisation of the haemodynamic, a tracheostomy was performed by the ENT surgeon successfully. The patient was transferred to the intensive care unit. It was decided not to initiate therapeutic

Figure 3 Postresuscitation chest X-ray with multiple signs of barotrauma; 2 days postresuscitation with bilateral apical pneumothoraces and free air under the diaphragm.

hypothermia due to the witnessed arrest and a relatively short duration of CPR.

OUTCOME AND FOLLOW-UP

The patient recovered without neurological deficits. Chest X-rays showed signs of barotraumas; the first day postresuscitation, the chest X-ray revealed a clear configuration of a pneumopericardium and subcutaneous emphysema (figure 2). The second day postresuscitation the chest X-ray showed bilateral apical pneumothoraces and free air under the diaphragm (figure 3). All these abnormalities resolved with conservative therapy. Unfortunately, the biopsies revealed a metastasis of the known pre-existing malignancy. The patient did not wish any further therapy and died 1 month after the incident. The definite cause of the upper airway obstruction remains unclear. Postoperative airway obstruction due to laryngeal oedema after a bilateral neck dissection and radiotherapy may be the most likely explanation of the upper airway obstruction.

DISCUSSION

A percutaneous transtracheal airway was first described in the early 1950s. Several years later, publications of percutaneous transtracheal ventilation appeared, with demonstration of adequate oxygenation.^{5–7} Soon thereafter the value of PTJV in an emergency setting was recognised.^{8–10} Subsequently, PTVJ was acknowledged as a technique in the algorithm of difficult airway in the first guidelines for management of the difficult airway by the American Society of Anesthesiologists.^{11 12} Multiple cases of PTJV are described, mainly in elective circumstances. Only few reports are describing PTJV in emergency settings.^{13–15} Besides being a method of temporary oxygenation and ventilation in emergency settings, PTJV has also been described as a guidance tool for fibre-optic intubation, which in our case was also helpful to establish a secured airway.¹⁶ However, none of them were actual CPR settings. To our knowledge this is the first report of PTJV in a CPR setting.

Airway rescue techniques are likely to be performed extremely rarely. Emergency percutaneous airway has an incidence of 1 in 12 500–50 000 general anaesthetics.² Cook et al also describe a success rate of an adequate emergency surgical airway by an anaesthesiologist as low as 36%. Periodical training of (manikin-based) airway rescue techniques is recommended and may be important contributors for improving success rates of emergency airway techniques and thus patient safety.¹⁷ Several studies already accentuate the importance of improving technical skills (TS) by training.^{18 19} Biro et al demonstrated clear improvements of TS after training sessions.²⁰ A recent editorial emphasised the importance of training the percutaneous emergency airway to enhance the success rate. Especially because it concerns low incidence high-risk procedures.²¹

Another important aspect, during a certain procedure, is good teamwork (eg, effective communication, situational awareness etc).^{2 22} Generally, human factors (HFs) have significant impact on patient safety.²³ Team processes do influence team performance and patient outcome.²⁴ For years, it has been recommended to train healthcare professionals in non-technical skills (NTS) such as leadership, situational awareness, decision-making, communication and assertiveness.^{25 26} The European Society of Anaesthesiology published the Helsinki Patient Safety Declaration in 2010.²⁷ It states that HFs play a large part in the delivery of safe care to patients and that operating room (OR) teams including surgeons, nurses and other healthcare professionals have to come together to reliably provide this. It concludes

that education plays a key role in improving patient safety and demanded that simulation-based team training should be part of the curricula to enhance communication and teamwork. In this particular case, the anaesthesia team was extensively trained in both TS (manikin-based PTJV) and NTS (communication, situational awareness, leadership, decision-making and assertiveness).

We described a case of a difficult airway with a hypoxic cardiopulmonary arrest in which we performed an emergency PTJV. Since these settings are extremely rare, skills and handling are likely to be unfamiliar. (Simulation-based) training of TS as well as NTS is important to improve patient safety.

Learning points

- ▶ Percutaneous transtracheal jet ventilation (PTJV) may be a life-saving rescue technique for initiating and maintaining oxygenation and ventilation in (un)anticipated difficult airway settings.
- ▶ Airway rescue technique skills and handling are likely to be unfamiliar; training of technical skills as well as non-technical skills is important to improve patient safety.
- ▶ Consider laryngeal oedema, in combination of a history of neck dissection and radiation therapy due to altered lymphatic drainage patterns, as a possible mechanism of an upper airway obstruction.

Contributors P-VD: data collection, draft of manuscript, read and approved the final version. Lth: data collection, draft of manuscript, critical revision of the manuscript for important intellectual content, read and approved the final version. RK: critical revision of the manuscript for important intellectual content, read and approved the final version.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

© BMJ Publishing Group Ltd (unless otherwise stated in the text of the article) 2018. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

REFERENCES

- 1 Siddiqui AS, Dogar SA, Lal S, et al. Airway management and postoperative length of hospital stay in patients undergoing head and neck cancer surgery. *J Anaesthesiol Clin Pharmacol* 2016;32:49–53.
- 2 Cook TM, Woodall N, Frerk C, et al. Major complications of airway management in the UK: results of the fourth national audit project of the royal college of anaesthetists and the difficult airway society. Part 1: anaesthesia. *Br J Anaesth* 2011;106:617–31.
- 3 Burkle CM, Walsh MT, Pryor SG, et al. Severe postextubation laryngeal obstruction: the role of prior neck dissection and radiation. *Anesth Analg* 2006;102:322–5.
- 4 Uehara M, Kokuryo S, Sasaguri M, et al. Emergency cricothyroidotomy for difficult airway management after asynchronous bilateral neck dissections: a case report and literature review. *J Oral Maxillofac Surg* 2015;73:2066.e1–7.
- 5 Reed JP, Kempf JP, Hamelberg W, et al. Studies with transtracheal artificial respiration. *Anesthesiology* 1954;15:28–41.
- 6 Flory FA, Hamelberg W, Jacoby JJ, et al. Transtracheal resuscitation. *J Am Med Assoc* 1956;162:625–8.
- 7 Spoerel WE, Narayanan PS, Singh NP. Transtracheal ventilation. *Br J Anaesth* 1971;43:932–9.
- 8 Jacobs HB. Emergency percutaneous transtracheal catheter and ventilator. *J Trauma* 1972;12:50–5.
- 9 Smith RB, Schaer WB, Pfaeffle H. Percutaneous transtracheal ventilation for anaesthesia and resuscitation: a review and report of complications. *Can Anaesth Soc J* 1975;22:607–12.
- 10 Benumof JL, Scheller MS. The importance of transtracheal jet ventilation in the management of the difficult airway. *Anesthesiology* 1989;71:769–78.
- 11 Entlein G, Byhahn C. Practice guidelines for management of the difficult airway. A report by the American society of anesthesiologists task force on management of the difficult airway. *Anesthesiology* 1993;78:597–602.

- 12 Apfelbaum JL, Hagberg CA, Caplan RA, *et al.* 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. *Anesthesiology* 2013;118:251–70.
- 13 Metz S, Parmet JL, Levitt JD. Failed emergency transtracheal ventilation through a 14-gauge intravenous catheter. *J Clin Anesth* 1996;8:58–62.
- 14 Biro P, Moe KS. Emergency transtracheal jet ventilation in high grade airway obstruction. *J Clin Anesth* 1997;9:604–7.
- 15 Divatia JV, Bhadra N, Kulkarni AP, *et al.* Failed intubation managed with subcricoid transtracheal jet ventilation followed by percutaneous tracheostomy. *Anesthesiology* 2002;96:1519–20.
- 16 Chandradeva K, Palin C, Ghosh SM, *et al.* Percutaneous transtracheal jet ventilation as a guide to tracheal intubation in severe upper airway obstruction from supraglottic oedema. *Br J Anaesth* 2005;94:683–6.
- 17 Cook TM, Nolan JP, Magee PT, *et al.* Needle cricothyroidotomy. *Anaesthesia* 2007;62:289–90.
- 18 Eppich WJ, Zonfrillo MR, Nelson KL, *et al.* Residents' mental model of bag-mask ventilation. *Pediatr Emerg Care* 2010;26:646–52.
- 19 Hamaekers AE, Henderson JJ. Equipment and strategies for emergency tracheal access in the adult patient. *Anaesthesia* 2011;66(Suppl 2):65–80.
- 20 Biro P, Grande B, Kind SL, *et al.* Concluding results from the first phase of the Zurich unexpected difficult airway course based on exercise of technical skills. *Anaesthesia* 2014;69:452–7.
- 21 Kristensen MS, Teoh WH, Baker PA. Percutaneous emergency airway access; prevention, preparation, technique and training. *Br J Anaesth* 2015;114:357–61.
- 22 Flin R, Fioratou E, Frerk C, *et al.* Human factors in the development of complications of airway management: preliminary evaluation of an interview tool. *Anaesthesia* 2013;68:817–25.
- 23 Cooper JB, Newbower RS, Long CD, *et al.* Preventable anesthesia mishaps: a study of human factors. 1978. *Qual Saf Health Care* 2002;11:277–82.
- 24 Manser T. Teamwork and patient safety in dynamic domains of healthcare: a review of the literature. *Acta Anaesthesiol Scand* 2009;53:143–51.
- 25 Kohn LT, Corrigan JM, Donaldson MS. *To err is human: building a safer health system*. Washington, DC: National Academy Press, 2000.
- 26 Berkenstadt H, Erez D, Munz Y, *et al.* Training and assessment of trauma management: the role of simulation-based medical education. *Anesthesiol Clin* 2007;25:65–74.
- 27 Mellin-Olsen J, Staender S, Whitaker DK, *et al.* The Helsinki Declaration on Patient Safety in Anaesthesiology. *Eur J Anaesthesiol* 2010;27:592–7.

Copyright 2017 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- Submit as many cases as you like
- Enjoy fast sympathetic peer review and rapid publication of accepted articles
- Access all the published articles
- Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow