CASE REPORT

Fatal endotracheal tube obstruction due to the ball valve effect

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SUMMARY

In patients suffering from pulmonary haemorrhage, or in patients who recently received a tracheostomy, acute occlusion of the endotracheal tube due to a blood clot is a rare, but well-known complication. Acute and complete occlusion of the tube is easily recognisable. There are various methods of removing the obstructive clot, such as using a bronchoscope with forceps, topical thrombolysis, saline lavage and suctioning. There are no guidelines concerning preventive routine bronchoscopic lavage. When there is a partial obstruction of the endotracheal tube, ventilation is possible, although high inspiratory pressures are necessary. If the clot functions as a ball valve ventil, raised intrathoracic pressure will cause right-sided heart failure or tension pneumothorax. It is important to recognise a partially obstructed tube in time and remove the obstruction.

BACKGROUND

Partial occlusion of the tube is a very serious complication and can have a fatal consequence. It is important to recognise a partially obstructed tube in time and remove the obstruction.

CASE PRESENTATION

Introduction

In the intensive care unit, occlusion of an endotracheal tube is a life-threatening event that, luckily, rarely happens.^{1 2} Since air movement is not possible, rapid desaturation will occur. It is important to recognise the obstruction and remove it as soon as possible. A partly occluded tube can be even more dangerous. Ventilation is only possible using high inspiratory pressures, which may cause a variety of complications.

Case report

A 76-year-old man was admitted to the intensive care unit with acute respiratory failure. A few hours earlier, he had presented at the emergency room where he was diagnosed with pneumonia.

Five years prior, the patient had suffered from a myocardial infarction. Since then he had been using acetylsalicylate acid and clopidogrel. During that admission, the patient had stated that he did not want to be resuscitated. He had lost his wife a few years earlier due to a cardiac arrest.

When the patient was admitted to the intensive care unit he was hypoxic with an oxygen saturation of 82%. Also, he was coughing up bloody mucus. It was decided to intubate immediately. After mechanical ventilation was started, oxygenation improved. Antibiotics were continued and all anticoagulants

were stopped. The pulmonologist performed a bronchoscopy, reporting some bloody clots that were very difficult to remove. After leaving some endobronchial mucolytics, the clots were removed the following day. On the sixth day of admittance, since obstruction pneumonia was suspected, bronchoscopy was repeated. At that time no blood clots were seen. Since the condition of the patient was improving, we started weaning him from the ventilator.

On the 8 day of stay at the intensive care unit, the patient suddenly became severely hypoxic and agitated. The nurses were unable to ventilate him by mechanical ventilation or by wateset balloon. Once the intensivist arrived the patient was severely hypoxic (saturation 57%), no breath sounds could be heard and bubbles were seen emerging from the patient's mouth. The patient was immediately sedated and a neuromuscular blocking agent was admitted. Laryngoscopy showed luxation of the tube with the cuff above the vocal cords. Since the initial intubation was deemed difficult, the tube was not changed. The same tube was repositioned below the vocal cords and connected to the wateset balloon. After a few inflations, there was immediate improvement of saturation (92%). However, approximately 20 s later the patient became hypotensive and bradycardic. Again, no breath sounds were heard and ventilation became impossible. We suspected bronchospasm. Salbutamol was given and the tube was disconnected from the balloon to relieve auto-positive end expiratory pressure (auto-PEEP). But even after manual compression of the thorax, no air movement was heard. Despite epinephrine given intravenously, the blood pressure declined further. Because of previous 'do not resuscitate' orders, cardiopulmonary resuscitation was not started and the patient died.

Once the tube was removed, desufflation of air was noticed. Inside the tube a big rigid mucus clot was found, partially obstructing the tube ([figure 1](#)).

DISCUSSION

There are several acute management steps to consider when assessing the deterioration of ventilation or oxygenation in an intubated patient. Use of the DOPE mnemonic to troubleshoot acute deterioration in a mechanically ventilated patient may be helpful. As a reminder, D is for dislodgement of the endotracheal tube, O for obstruction, P for suspected pneumothorax and E for equipment or operator problems.¹

At reconstruction, we suspected that initially the tube was occluded by the bloody mucus plug,

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Figure 1 Picture of the tube after removal, partially occluded with bloody mucus.

resulting in impaired ventilation. Owing to agitation and probably raised intrapulmonary pressure, the patient was able to displace the tube above the vocal cords. After sedating the patient and repositioning of the tube a few inflations resulted not only in improved oxygenation, but also in fast rising intrathoracic pressure. Since the plug worked as a ball valve ventil, air went in, but was not able to get out, causing auto-PEEP. The raised intrapulmonary pressure resulted in acute right-sided heart failure and cardiac arrest.

Some lessons can be learned from this case.

First, the patient became hypoxic due to occlusion of the tube. Occlusion of the tube is a serious, life-threatening event and, luckily, occurs very rare.² However, for patients suffering from intrapulmonary haemorrhage, acute occlusion of the tube is described.³ After placement of a tracheostoma, formation of bloody mucus clots resulting in tube obstruction is a rare but well-known complication.⁴ In cases of acute occlusion, the quickest method of removal of the clot is the best. Some case reports describe using a bronchoscope with forceps; others have removed the clot by topical thrombolysis, saline lavage and suctioning.^{5 6} When it is not possible to remove the obstruction quickly, one should detubate, provide the patient with oxygen and prepare for a rapid reintubation when necessary.

Prevention of tube occlusion is very important. Administration of humidified air and regular bronchial suctioning when a mucus clot is suspected is standard care. To the best of our knowledge, no guideline exists on regular bronchoscopic lavage in patients with haemoptysis. An advantage could be early notice of clots and possible removal. However, bronchoscopy can also cause complications such as stress, hypoxia, loss of positive expiratory end pressure, removal of surfactant and bleeding. Also, some pulmonologists doubt whether saline lavage can actually dissolve the clots, or whether instead it causes the clots already formed to migrate to smaller bronchioles, causing obstruction.⁷

Second, our patient died because of acute right-sided heart failure caused by raised intrathoracic pressure. The clot in the

tube worked as a 'ball valve' ventil.⁸ Air was manually inflated in the lung, but expiration was not possible. The clot acted as a one-way valve. The consequence is pulmonary hyperexpansion. This results in haemodynamic compromise, sometimes due to acute right-sided heart failure. Some case reports describe occurrence of a (bilateral) tension pneumothorax due to abnormally high peak inspiratory pressures, causing a rupture of the pleura.⁹ Treatment consists of removal of the clot, and when that is not possible quickly enough, removal of the tube. When a tension pneumothorax is suspected, the patient should be treated accordingly, by urgent decompression.

CONCLUSION

In conclusion, we present a patient who became severely hypoxic due to occlusion of the endotracheal tube. Owing to panic and probably already raised intrapulmonary pressure, the patient managed to luxate the tube with the cuff above the vocal cords. After replacement of the tube, initially the oxygenation improved. But shortly thereafter, the patient died due to right-sided heart failure caused by raised intrapulmonary pressure. The clot in the tube functioned as a ball valve mechanism, allowing air entry into the lower respiratory tract during inspiration, but blocking the expiratory flow.

Partial occlusion of the tube is a very serious complication and can have a fatal consequence. Therefore, when one is not able to remove the obstruction in time, the adage 'when in doubt, take it out' seems appropriate.

Learning points

- ▶ When there is a partial obstruction of the endotracheal tube, ventilation is possible, although high inspiratory pressures are necessary.
- ▶ If a tube is partially occluded, the clot could function as a ball valve mechanism.
- ▶ Raised intrathoracic pressure can cause right-sided heart failure or tension pneumothorax.

Competing interests None.

Patient consent Obtained.

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