Unilateral subcutaneous emphysema after percutaneous tracheostomy

[Emphysème sous-cutané unilatéral après une trachéotomie percutanée]

Jee Jian See MMED, David T. Wong MD

Purpose: Percutaneous tracheostomy techniques are widely used in intensive care units. Subcutaneous emphysema is a rare but well recognized complication associated with this procedure. We report an unusual presentation of sc emphysema after percutaneous tracheostomy. The clinical features, diagnosis and postulated mechanism are discussed.

Clinical features: A 39-yr-old man had percutaneous tracheostomy done after prolonged intubation in the intensive care unit. Subcutaneous emphysema developed over the right neck three days after the procedure. Associated skin erythema and fever mimicking deep sc infection resulted in neck exploration. No obvious lesion was found in the tracheobronchial tree.

Conclusion: Subcutaneous emphysema occurring after percutaneous tracheostomy could occur without significant injury to the tracheobronchial tree. We postulate that air leaking from the tracheostomy site might have been prevented by the snug fit between the tracheostomy tube and the skin, resulting in accumulation in the neck. Asymmetric dilatation of the trachea may explain the unilateral localization of the sc emphysema.

Objectif : Les techniques de trachéotomie percutanée sont largement utilisées dans les unités de soins intensifs (USI). L'emphysème sous-cutané est une complication rare, mais bien connue, associée à cette intervention. Nous présentons un cas inhabituel d'emphysème sc suivant une trachéotomie percutanée.

Éléments cliniques : Une trachéotomie percutanée a été pratiquée chez un homme de 39 ans à la suite d'une intubation prolongée à l'USI. Un emphysème sous-cutané s'est développé au côté droit du cou trois jours après l'intervention. Un érythème associé et une fièvre rappelant une infection sc profonde ont incité à une exploration du cou. Il n'y avait aucune évidence de lésion dans l'arbre trachéobronchique.

Conclusion : L'emphysème sous-cutané observé après une trachéotomie percutanée peut survenir sans lésion significative de l'arbre trachéobronchique. Nous croyons que l'infiltration gazeuse, provoquant l'accumulation d'air dans le cou, aurait pu être évitée par un bon ajustement entre le tube de trachéotomie et la peau. La dilatation asymétrique de la trachée peut expliquer la localisation unilatérale de l'emphysème sc.

PERCUTANEOUS tracheostomy techniques are widely used in intensive care units for patients who need long-term ventilation. Subcutaneous emphysema is a rare but well recognized complication associated with this procedure. After obtaining informed consent from the patient, we report a case of sc emphysema localized predominantly on one side of the neck, that presented late after percutaneous tracheostomy, mimicking sc infection of the neck.

Case description

A 39-yr-old man (weight 110 kg, height 187 cm) was diagnosed to have a left sided acoustic neuroma (vestibular schwannoma) after he presented with left ear hearing loss and tinnitus. He underwent surgical removal of the acoustic neuroma. There was no intraoperative complication and he was ventilated postoperatively in view of the long duration of the operation. His postoperative course was complicated by development of intracerebral hematoma for which emergent evacuation was performed. Thirteen days postoperatively, he was on minimal ventilatory sup-

From the Department of Anesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ontario, Canada.

Address correspondence to: Dr. David T. Wong, Department of Anesthesiology, Toronto Western Hospital, 399 Bathurst Street, McL 2-405, Toronto, Ontario M5T 2S8, Canada. Phone: 416-603-5118; Fax: 416-603-6494; E-mail: david.wong@uhn.on.ca

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FIGURE A (left) Computed tomography scan of the neck (level of thyroid cartilage): major collection of *sc* air outlined by arrows measuring 95 mm × 35 mm. Note numerous small pockets of air on both sides of the neck.
 FIGURE B (right) Computed tomography scan of the neck (level of lower mandible): major collection of *sc* air mass outlined by arrows measuring 110 mm × 60 mm. Note numerous small pockets of air on both sides of the neck.

port requiring pressure support ventilation of 10 cm H₂O. However, he remained drowsy, had significant bulbar dysfunction and right-sided hemiparesis, so extubation was not attempted. Percutaneous tracheostomy was performed using the Ciaglia Blue Rhino Percutaneous tracheostomy set (Cook Inc, Bloomington, IN, USA) after two weeks in the intensive care unit. A size 8 Shiley non-fenestrated tracheostomy tube (Tyco Healthcare, Pleasanton, CA, USA) was inserted under direct guidance with the bronchoscope. The patient had easily identifiable anatomical landmarks and the procedure was uncomplicated. The patency of the tracheostomy was confirmed at the end of the procedure using the bronchoscope. No difficulty was encountered in ventilation of the patient. Shortly after the procedure, spontaneous respiration resumed, and a tracheostomy mask was applied. He tolerated that well, and was able to maintain oxygen saturation above 95% with F_IO₂ at 30%. Arterial carbon dioxide level was also normal. A chest radiograph done after the procedure did not show any evidence of *sc* emphysema. A one-way valve was not used during his stay in the intensive care unit.

Three days after insertion of tracheostomy, following an episode of protracted coughing and straining, swelling and crepitations were observed on the right

side of the neck. This was accompanied by erythema, fever up to 39.1°C, and moderate leukocytosis (total white count ranged between $12.1 \times 10^9 \cdot L^{-1}$ to $18.5 \times 10^9 \cdot L^{-1}$ with left shift). A computed tomography scan showed a significant amount of *sc* emphysema in the high right lateral compartment of the neck, extending to the larynx. The gas was noted to be remote from the tracheostomy site. The trachea was midline and there was no radiological evidence of tracheal tear or tracheoesophageal fistula (Figure). A presumptive diagnosis of *sc* infection of the right neck was made. The patient was started on systemic antibiotics and exploration of the neck under general anesthesia was performed. Panendoscopy revealed no significant injuries to the larynx, esophagus, anterior or posterior tracheal wall. No collection of pus or hematoma was observed. The tracheostomy skin incision site was enlarged. The wound cultures taken were negative. After neck exploration and a course of antibiotics, the patient's fever and skin erythema resolved with no serious sequelae.

After a prolonged stay in the intensive care unit and rehabilitation, the patient recovered neurologically. After six weeks, he regained cognition, but remained slightly unsteady on standing. He was discharged from hospital at that time.

Discussion

Percutaneous dilatational tracheostomy (PDT) is an increasingly common procedure in the intensive care unit for patients who need long-term ventilation.^{1,2} The procedure is reportedly safe and effective.³⁻⁵ Most complications are minor and easy to manage. The overall complication rate is reported to be 3 to 6%,^{5,6} and is mostly related to the tracheostomy tube (malposition, accidental decannulation, kinking, obstruction and cuff herniation or rupture) and bleeding. Manifestations of barotrauma including *sc* emphysema, pneumothorax and pneumomediastinum, are other significant but less common complications. Use of a bronchoscope to guide insertion has contributed to lower complication rates, and is considered an essential part of the procedure of PDT.^{7,8} Byhahn *et al.* observed that obese patients with body mass index greater than 27.5 kg·m² had a 2.7-fold increased risk of complications after PDT. Both minor and major complication rates were higher in the obese patients, and Byhahn *et al.* suggested that PDT might expose obese patients to a higher risk of adverse event.⁹ However, the anatomical landmarks were easily identifiable in our patient and thus it was felt that there was no contraindication to performing PDT.

Subcutaneous emphysema is a relatively uncommon complication following PDT with an incidence of 1.4%.¹⁰ Various mechanisms have been postulated as causes for development of *sc* emphysema. These include malpositioning, misplacement or dislocation of tracheostomy tube¹¹ and high ventilatory pressures. Air-leak from extra luminal localization of fenestrations could lead to *sc* emphysema.¹² Thus, the use of fenestrated tubes immediately after PDT should be avoided.¹⁰ Tears in the posterior tracheal wall, caused by the tip of the loading catheter or the tip of the dilating forceps in the guide wire dilating forceps method, have also been reported to be a cause of *sc* emphysema.^{10,13,14} Fikkers *et al.* demonstrated in cadavers that *sc* emphysema could also be caused by air leakage from the anterior tracheal wall. Air may track along the *sc* plane when there is a tracheal defect without a route from which the air may escape via the skin.¹⁰ Other risk factors include excessive dilatation of the anterior tracheal wall, and multiple punctures.

In the patient described, there were several features that made diagnosis of *sc* emphysema difficult. The delayed onset of *sc* emphysema after PDT was unusual. In the literature, most cases occurred within several hours after the procedure.^{10,13} In our patient, *sc* emphysema did not manifest until three days after the procedure. We hypothesized that there was no significant injury to the tracheal wall or malposition of

the tracheostomy tube, as these would have resulted in immediate or rapid manifestation of *sc* emphysema. This was confirmed during subsequent surgical exploration of the neck. Furthermore, in a spontaneously breathing patient, the clinical manifestations of *sc* emphysema may also be delayed. The postulated mechanism of *sc* emphysema in our patient was similar to that described by Fikkers *et al.*¹⁰ Due to conic dilatation of the skin and trachea used in the Blue Rhino method, the fit between the tracheostomy tube and skin tends to be tight, whereas the fit between the tracheostomy tube and the trachea tends to be less snug due the cartilaginous content of the trachea. When there is high airway pressure, for example during vigorous coughing combined with blockage of the tracheostomy tube by respiratory secretions, air may track out of the anterior trachea along the cervical planes into the neck. In contrast, during surgical tracheostomy, the skin incision will allow air to leak out around the junction of skin and the tracheostomy tube to the atmosphere.

Another unusual feature observed in this patient was the presence of *sc* air, predominantly over the right side of the neck and remote from the site of the tracheostomy. In most cases, *sc* emphysema tends to be central and symmetric. However, in this patient, air was trapped primarily in the right side of the neck. We speculate that there could have been an asymmetric dilatation of the trachea during the procedure. Even with bronchoscopic guidance, more of the right side of the trachea could have been dilated during PDT, rather than the central aspect, allowing gas to track on the right side preferentially. With tracking of air and possible spillage of respiratory secretions up the neck, secondary infection on the side of the neck was expected. Previous central venous catheter insertion into the right internal jugular vein may also have contributed to superficial skin infection. However, the central venous catheter had been removed two weeks prior to the development of *sc* emphysema, making its contribution to the development of *sc* emphysema unlikely.

Within the differential diagnosis, an important cause to exclude is deep *sc* infection from a gas-forming organism.¹⁵ While uncommon, the presence of gas forming organisms at the site of central line placement with *sc* emphysema has been reported.¹⁶ The management is also vastly different, requiring extensive surgical debridement in patients with infection compared to a conservative approach in patients with *sc* emphysema. Patients who develop deep cervical infection usually have additional risk factors including impaired immunity, diabetes, chronic renal failure, chemotherapy, and poor nutritional states,¹⁷ and may present

with systemic sepsis. Computed tomography scan features that may be helpful in differentiating necrotizing fasciitis of the neck from superficial infection include diffuse thickening of the fasciae, asymmetric thickening of cervical muscles and fluid collection in multiple neck spaces. These features were absent in our patient. Presence of a small quantity of gas on the contralateral side of the neck where the overlying skin was normal was another feature that suggested air leak as the cause of the *sc* emphysema.

In summary, we report a case of neck *sc* emphysema presenting late after an uncomplicated PDT. The cause of *sc* emphysema was unrelated to anterior or posterior tracheal tears, or *sc* infection of the neck. We postulate that the development of *sc* emphysema was due to the accumulation of air leaking from the anterior tracheal wall, which could not escape due to the snug fit between the tracheostomy tube and skin. Clinicians should be aware of the differential diagnosis of neck *sc* emphysema and be prepared to manage accordingly.

References

- 1 Cooper RM. Use and safety of percutaneous tracheostomy in intensive care. Report of a postal survey of ICU practice. *Anaesthesia* 1998; 53: 1209–12.
- 2 Fischler L, Erhart S, Kleger GR, Frutiger A. Prevalence of tracheostomy in ICU patients. A nation-wide survey in Switzerland. *Intensive Care Med* 2000; 26: 1428–33.
- 3 Beiderlinden M, Walz KM, Sander A, Groeben H, Peters J. Complications of bronchoscopically guided percutaneous dilational tracheostomy: beyond the learning curve. *Intensive Care Med* 2002; 28: 59–62.
- 4 Freeman BD, Isabella K, Lin N, Buchman TG. A meta-analysis of prospective trials comparing percutaneous and surgical tracheostomy in critically ill patients. *Chest* 2000; 118: 1412–8.
- 5 Polderman KH, Spijksstra JJ, de Bree R, et al. Percutaneous dilatational tracheostomy in the ICU. Optimal organization, low complication rates, and description of a new complication. *Chest* 2003; 123: 1595–602.
- 6 Kearney PA, Griffen MM, Ochoa JB, Boulanger BR, Tseui BJ, Mentzer RM Jr. A single-center 8-year experience with percutaneous dilational tracheostomy. *Ann Surg* 2000; 231: 701–9.
- 7 Ciaglia P. Video-assisted endoscopy, not just endoscopy, for percutaneous dilatational tracheostomy. *Chest* 1999; 115: 915–6.
- 8 Hinerman R, Alvarez F, Keller CA. Outcome of bedside percutaneous tracheostomy with bronchoscopic guidance. *Intensive Care Med* 2000; 26: 1850–6.
- 9 Byholm C, Lischke V, Meininger D, Halbig S, Westphal K. Peri-operative complications during percutaneous tracheostomy in obese patients. *Anaesthesia* 2005; 60: 12–5.
- 10 Fikkers BG, van Veen JA, Kooloos JG, et al. Emphysema and pneumothorax after percutaneous tracheostomy. Case reports and an anatomic study. *Chest* 2004; 125: 1805–14.
- 11 Escarment J, Suppini A, Sallaberry M, et al. Percutaneous tracheostomy by forceps dilation: report of 162 cases. *Anaesthesia* 2000; 55: 125–30.
- 12 Mostert MJ, Stuart H. Subcutaneous emphysema caused by a fenestrated tracheostomy tube. *Anaesthesia* 2001; 56: 191–2.
- 13 Douglas WE, Flabouris A. Surgical emphysema following percutaneous tracheostomy. *Anaesth Intensive Care* 1999; 27: 69–72.
- 14 Kaylie DM, Wax MK. Massive subcutaneous emphysema following percutaneous tracheostomy. *Am J Otolaryngol* 2002; 23: 300–2.
- 15 Wong DT, McGuire GP. Subcutaneous emphysema following trans-cricothyroid membrane injection of local anesthetic. *Can J Anesth* 2000; 47: 165–8.
- 16 O'Rourke J, Fahy C, Donnelly M. Subcutaneous emphysema at the site of central line placement due to the haematogenous spread of *Clostridium septicum* (Letter). *Eur J Anaesthesiol* 2003; 20: 162–3.
- 17 Durrani MA, Mansfield JF. Anesthetic implications of cervicofacial necrotizing fasciitis. *J Clin Anesth* 2003; 15: 378–81.