Subcutaneous emphysema following Trans-Cricothyroid Membrane injection of local anesthetic

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Purpose: To present a case of preoperative subcutaneous emphysema (SCE) as a complication of trans-cricothyroid membrane (TCM) injection of lidocaine for awake intubation.

Clinical features: A 48-yr-old man with cervical myelopathy was scheduled for elective cervical discectomy. Airway topical anesthesia consisted of lidocaine pledgets and TCM injection. After successful awake fiberoptic intubation was performed, SCE was noted in the neck region. The main differential diagnosis of preoperative SCE included air leak via the anterior needle track from TCM injection or disruption of mucosal membrane in the aerodigestive tract. The latter was excluded by panendoscopy and an upper GI swallow study. The most likely explanation for SCE was air leak from the anterior needle tract. The subcutaneous emphysema resolved spontaneously without sequelae.

Conclusion: Subcutaneous emphysema is a rare but potentially serious complication of TCM injection of lidocaine. Anesthesiologists should be familiar with the differential diagnosis, investigations and management of SCE.

Objectif : Présenter un cas d'emphysème sous-cutané préopératoire (ESC) comme complication d'une injection de lidocaïne au travers de la membrane cricothyroïdienne (MCT) lors d'une intubation vigile.

Éléments cliniques : Un homme de 48 ans présentant une myélopathie cervicale devait subir une discectomie cervicale. L'anesthésie topique des voies aériennes comprenait des tampons de lidocaïne et une injection au travers de la MCT. Une intubation fibroscopique vigile a été réalisée avec succès, mais un ESC a été noté ensuite dans la région du cou. Le diagnostic différentiel d'ESC préopératoire incluant une fuite d'air provenant du tractus antérieur emprunté par l'aiguille lors de l'injection dans la MCT ou une rupture de la membrane muqueuse du tractus aéro-digestif. Cette dernière a été rejetée par la panendoscopie et une étude GI supérieure de la déglutition. L'explication la plus plausible d'un ESC a été une fuite d'air du tractus antérieur emprunté par l'aiguille. L'emphysème sous-cutané s'est résorbé spontanément sans séquelles.

Conclusion : L'emphysème sous-cutané est une complication rare mais potentiellement grave d'une injection de lidocaïne au travers de la MCT. Les anesthésiologistes doivent se familiariser avec le diagnostic différentiel, l'évaluation et le traitement de l'ESC.

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TRANS-CRICOTHYROID membrane (TCM) injection of local anesthetic is commonly performed prior to awake fiberoptic bronchoscopic (FOB) intubation. We report a case of subcutaneous emphysema (SCE) after TCM injection of local anesthetic. The differential diagnosis and management of perioperative SCE are described.

Case Report

A 48-yr-old man was scheduled for elective anterior cervical discectomy and fusion (C₅₋₇) due to cervical radiculopathy and myelopathy. Magnetic resonance imaging showed lateral disc herniations at C₅₋₆ and C₆₋₇ with osteophytes at C₆₋₇ causing moderate bilateral foraminal stenosis and compression of the spinal cord. He did not have any underlying cardio-pulmonary disease, diabetes and was taking no medications. Awake intubation was agreed upon by the patient and surgeon.

In the operating room, electrocardiogram, blood pressure cuff, oximetry were applied and intravenous, arterial lines were inserted. Topical airway anesthesia was applied with lidocaine gargle (2%), pledgets with forceps (4%) and TCM injection (2%). Trans-cricothyroid membrane injection consisted of the following: after gaining entry into airway via a 22 g, 2.5 cm intravenous catheter, as evident by easy aspiration of air, the intravenous catheter needle was removed and air was again aspirated via the catheter using a syringe, 4 ml lidocaine 2% were injected into the trachea; then the intravenous catheter was promptly removed. The patient coughed at the time of the injection. Intravenous midazolam was given for sedation and 0.3 mg glycopyrrolate was given as an antisialagogue. Oral fiberoptic bronchoscopy (FOB) was performed by an anesthesiologist in training. There were some difficulties in visualizing the larynx due to secretions and inability to maintain the FOB in the midline. No obvious mucosal bleeding or trauma was observed. After spending ten minutes with the FOB in the supraglottic area, the larynx was adequately visualized and the FOB was advanced into the trachea without any difficulty. Then, an oral 8.0 mm ID endotracheal tube was passed over the FOB into the trachea easily. Correct endotracheal tube positioning was confirmed by FOB and by auscultation.

After examining the patient's neurological function, he was anesthetized with propofol, pancuronium and fentanyl. The patient's lungs were ventilated with a tidal volume of 10 ml·kg⁻¹ at a frequency of eight breaths per minute. The airway pressure was 18/2 cm water. Anesthesia was maintained with isoflurane, O₂/N₂O at a 33/67% ratio. Three minutes post-intubation, the surgeon noted palpable SCE extending

from suprasternal to submandibular region bilaterally. There was no clinical evidence of pneumothorax. Hemodynamic and respiratory parameters were stable.

At that time, the differential diagnosis of SCE prior to surgery included: 1) air leak into subcutaneous tissue via anterior needle tract extending from airway mucosa at level of cricothyroid membrane to skin, 2) air leak from mucosal tear in the aerodigestive tract (hypopharynx, larynx, trachea or esophagus) resulting from trauma of FOB or endotracheal tube insertion, or 3) air leak into mediastinum and subcutaneous tissue via posterior needle track from puncture of posterior tracheal wall from intravenous catheter. An otolaryngology surgeon performed rigid laryngoscopy, fiberoptic bronchoscopy and pharyngoscopy. There was no evidence of mucosal tear or perforation in the pharynx or larynx and no evidence of posterior tracheal wall injury. A gastrograffin swallow study was suggested to exclude perforations of esophagus. Subcutaneous emphysema subsided in 30 min without intervention.

Due to concern about infectious potential, the proposed surgery was canceled. The reason was that if the subcutaneous emphysema was caused by traumatic tear of airway or esophageal mucosa, and cervical spinal surgery was performed, then the surgical site and bone grafts could become infected with oropharyngeal bacteria postoperatively. The patient emerged from anesthesia and the trachea was extubated uneventfully. A chest radiograph performed in the recovery room did not show pneumothorax or mediastinal air. A gastrograffin swallow gastrointestinal study was negative.

We believe that the most likely cause of the SCE was air leaking from the subglottic area via an anterior needle track created from TCM injection to the soft tissue in neck, and not from mucosal tear of the aerodigestive tract from airway instrumentation, or by a posterior needle track. Air was driven into the subcutaneous tissue via the anterior needle tract by the patient coughing. The amount of SCE could be exacerbated by the use of nitrous oxide.

Two weeks later, the patient was brought back for elective surgery. Various methods to topicalize the airway were considered including: atomization, nebulization, direct spray, pledgets and injection via bronchoscopic suction port. We proceeded to topicalize the airway using lidocaine gargle and atomization of 20 ml lidocaine 4% connected to an oxygen flow at eight L·min⁻¹. TCM injection was not performed. Fiberoptic bronchoscopic directed intubation was then performed successfully without cough or complications.

Discussion

Differential diagnosis

Subcutaneous emphysema and other manifestations of barotrauma are commonly seen in the critical care setting but rarely in the operating room. The differential diagnosis include disruption of cutaneous barriers, disruption of mucosal barriers, barotrauma and infection (Table I).¹⁻⁵ From an anatomical standpoint, mucous membrane disruption of the oropharynx, hypopharynx, tracheal-bronchial tree and esophagus can lead to SCE. In this report, we described a case of SCE from TCM injection which to our knowledge, has not been previously described.

From an anesthesiologist's perspective, two conditions among the differential diagnosis outlined in the Table warrant further attention. First, although tracheal intubation is a relatively safe procedure, esophageal or hypopharyngeal perforation can occur with traumatic laryngoscopy or intubation.^{6,7} The most likely sites of perforation are at the posterior esophagus, at the distal cricoid pharyngeal muscle or at the piriform sinus.¹ Important risk factors for esophageal or pharyngeal perforation include inexperienced personnel, difficult airway and emergency situations.^{1,6} Subcutaneous emphysema may be an early clue to this catastrophic complication. However, esophageal or pharyngeal perforation may not be detected until after surgery when symptoms and signs of mediastinitis, such as fever, dysphagia, dysphonia and SCE, develop. Second, SCE may result from barotrauma of positive pressure ventilation. How does barotrauma result in SCE? The first explanation is rupture of the alveolar membrane resulting in pneumothorax. Then, with building up of pressure, a further breakage of parietal pleura ensues resulting in subcutaneous air.⁸ The second and the more likely explanation is rupture of the alveolar membrane leading to interstitial air, which subsequently dissect proximally along peribronchial tissue causing pneumomediastinum. Air in the mediastinum decompresses along tissue planes resulting in subcutaneous air in the head and neck area, arms, chest and retroperitoneal space.⁸ Risk factors for barotrauma include high peak, mean, positive end expiratory airway pressure, weakened alveolar membrane from emphysema or infection, coughing and Valsalva maneuver. In the operating room, additional risk factors include compromised anesthesia circuit, failed pop-off valve, faulty oxygen flush mechanism and excessive tidal volume settings.

Investigations and management

Many of the SCE cases are self limiting without serious sequella. Conservative management consisting of observation and oxygen therapy would be appropriate.

TABLE Differential diagnosis of subcutaneous emphysema

1	Disruption of cutaneous barriers
	a) Surgery; eg. tracheostomy, neck dissection
	b) External trauma
2	Disruption of mucosal barriers
	a) Tracheal intubation complications; injury to piriform sinus, hypopharynx valleculae or esophagus
	b) Endoscopy; eg gastroscopy
	c) Dental surgery; eg extraction, intraoral injection, use of high pressure instruments
	d) Facial bone fracture
	e) Trauma: penetrating or blunt
	f) Percutaneous tubes: gastrostomy or chest tube
	g) Foreign body
	h) Neoplasm
3	Barotrauma: rupture of alveolar membrane
	a) Positive pressure ventilation
	b) Valsalva
	c) Asthma
	d) Drug inhalation
	e) Labour
4	Infection: bacterial
	a) Anaerobic; eg. clostridial
	b) Gas forming facultative aerobic
	c) Mixed infections

Positive pressure ventilation should be avoided. Further investigations should be ordered based on the degree of clinical suspicion. However, SCE in the setting of aerodigestive tract instrumentation or trauma should be considered serious until proven otherwise. Life threatening causes of SCE such as esophageal perforation or septic cellulitis, and serious complications such as tension pneumothorax, mediastinitis or tension pneumopericardium require definitive diagnosis and appropriate treatment.¹⁻⁵ Unrecognized esophageal perforation can lead to mediastinitis with mortality as high as 50%.¹ Therefore, when esophageal or pharyngeal perforation is suspected following instrumentation or intubation, early diagnosis by endoscopy and radiological studies is indicated to allow prompt surgical repair if positive. Septic cellulitis or retropharyngeal abscesses require surgical debridement and antibiotic therapy. Tension pneumothorax requires urgent decompression by percutaneous catheter or thorocostomy. Tension pneumomediastinum may result in hypotension from obstruction of venous return or in airway obstruction from tracheal compression in infants. Tension pneumopericardium resulting in tamponade requires urgent pericardiocentesis.

For patients with head, neck, chest or arm SCE, a plain chest radiograph should be performed. It will confirm the presence of subcutaneous air and detect if a pneumothorax, pneumomediastinum or pneu-

mopericardium are present. If esophageal or pharyngeal perforation is suspected in the setting of trauma or instrumentation, panendoscopy and a barium upper GI swallow should be done, as radiological studies may not detect all injuries of the aerodigestive tract.² For those with suspected neck or mediastinal abscesses, a contrast computerized tomography or magnetic resonance imaging should be done.

Conclusion

When SCE is encountered in the perioperative setting, serious causes and complications must be recognized and treated accordingly. The anesthesiologist should be familiar with the differential diagnosis, investigations and management of perioperative SCE. We describe SCE as an unusual complication following TCM injection of lidocaine. Other effective methods to anesthetize the airway such as atomization and instillation of local anesthetics through the FOB should be considered as an alternative to TCM injection of local anesthetics.

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