late ganglion blocks, the residual postherpetic neuralgia became more prominent and persisted for several months.

In conclusion, a case of segmental RSDS, occurring concomitantly with postherpetic neuralgia, is presented. Recognition of this possibility may initiate early RSDS therapy, thus preventing irreversible dystrophic complications.

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Delayed Pneumothorax Following Difficult Tracheal Intubation

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Tracheal intubation is associated with a number of complications. Most complications are immediately apparent and, once recognized, can be readily treated. Less commonly, problems associated with intubation become apparent at a time distant to the intubation itself. We present a case in which a difficult tracheal intubation led to pneumothorax, pneumomediastinum, and subcutaneous emphysema developing in the postoperative period, after the patient’s trachea was extubated.

CASE REPORT

A 64-yr-old, 47-kg healthy woman with degenerative joint disease was scheduled for a right total knee arthroplasty. The patient’s past medical history was otherwise unremarkable. She smoked in the past, but stopped smoking 15 yr prior to this admission. Her only previous surgical procedure was a tonsillectomy at 3 yr of age. The physical examination was normal, except for the patient’s airway. She had a slightly reduced ability to extend her neck and the distance between the hyoid bone and mental protuberance measured only two finger breadths (approximately 3.5 cm). Otherwise her head and neck were normal in appearance with normal dentition and full range of motion at the temporomandibular joint. Despite these abnormalities, examination of the patient’s oropharynx provided good visualization of the soft palate and uvula, consistent with a class 1 airway as described by Mallampati et al. Preoperative chest x-ray and laboratory test results were normal.

Anesthesia was induced with 250 mg sodium thiopeptol and 10 mg morphine sulfate. Ease of assisted ventilation was confirmed and 5 mg vecuronium was administered to facilitate tracheal intubation. After achieving adequate muscle relaxation as documented by a peripheral nerve stimulator, laryngoscopy was performed using a Macintosh #3 blade. The larynx could not be visualized. Assisted ventilation of the lungs via face mask was re instituted, head position altered, and a second attempt at laryngoscopy made without improvement of vocal cord visualization. A subsequent attempt was made to visualize the vocal cords by a second anesthesiologist. In addition to manipulation of the patient’s head, gentle posterior pressure was applied to the cricoid cartilage. This facilitated visualization of the posterior aspect of the larynx, although the vocal cords still could not be visualized. Tracheal intubation was accomplished using a 7.0-mm endotracheal tube (ETT) with a stylet, which was used to provide steep anterior angulation of the tip.
of the tube. The tip of the stylet was well within the ETT, proximal to the Murphy eye. After the endotracheal tube tip was advanced through the vocal cords, the anesthesiologist noted difficulty passing the tube further. The stylet was removed by an assistant; there was considerable resistance to its removal due to the anterior angulation within the tube. After tracheal intubation, breath sounds were heard equally in both lung fields. The oropharynx and hypopharynx were examined and demonstrated no apparent evidence of trauma.

Anesthesia was maintained for the 2-hr surgical procedure using isoflurane, nitrous oxide, and oxygen. The patient’s lungs were mechanically ventilated with a delivered tidal volume of 400–500 ml (8.5–10.5 ml/kg) and a respiratory rate of 5–6 breaths/min. The peak airway pressure remained less than 20 cm H₂O and breath sounds were normal throughout the procedure. Hemoglobin oxygen saturation (SpO₂) remained ≥98%. End-tidal CO₂ (PetCO₂) was monitored by mass spectrometer and remained 33–35 mmHg. The surgical procedure was performed without difficulty.

After completion of the operation, anesthesia was discontinued, the patient awoke, and her trachea was extubated without difficulty. She was transported to the post anesthesia care unit (PACU) where she was noted to be awake, communicative, and in no distress.

Forty-five minutes after the patient’s admission to the PACU, it was noted that extensive subcutaneous emphysema had developed in the lower portion of her face, neck, trunk, and upper extremities. The examination was remarkable for extensive palpable crepitus. Breath sounds were clear and equal bilaterally. Over the next 2 h the patient remained asymptomatic, although she did complain of an inability to “clear my throat.” The patient’s voice was normal. She had no cough, dyspnea, or dysphagia. She denied straining, sneezing, crying, or other activity that might cause an acute increase in intrathoracic pressure.

A portable chest x-ray revealed diffuse subcutaneous emphysema, a small right pneumothorax, possible pneumomediastinum, and extensive pneumoperitoneum.

To evaluate the potential cause for the extrapulmonary air, flexible fiberoptic oropharyngeal examination was performed in the PACU, revealing a normal oropharynx and hypopharynx. The epiglottis showed a small echymotic area at its right base, and the right cuneiform-artery complex appeared minimally edematous. The vocal cords were normal in appearance and motion. Just below the vocal cords the anterior tracheal wall had a 2–3-cm long erythematous streak. There was no overt bleeding, nor noticeable soft tissue disruption or flap.

The patient’s subsequent postoperative course was uneventful. The subcutaneous emphysema completely resolved by the fifth postoperative day, while the pneumothorax and pneumoperitoneum persisted through the tenth postoperative day, at which time the patient was discharged. Her temperature and leukocyte count remained normal throughout her hospitalization. Chest x-ray obtained 35 days after her initial surgery demonstrated complete resolution of her pneumothorax and pneumoperitoneum.

DISCUSSION

This case represents an unusual presentation of extrapulmonary air becoming apparent postoperatively in a patient undergoing total knee arthroplasty. The potential causes for the pneumothorax and subcutaneous air in this patient include incidental spontaneous pneumothorax, pneumothorax as a complication of positive pressure ventilation, or disruption of the trachea or pyriform sinus at the time of intubation. Based on the difficulty with

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The intubation and the patient’s clinical course, the most likely etiology for the pneumothorax, pneumomediastinum, and subcutaneous air is a tracheal tear through which air was entrained into the soft tissues of the neck, with subsequent dissection into the pleural space and peritoneal cavity. The timing of onset of extrapulmonary air and the predominant locations of air accumulation are consistent with the development of a spontaneous pneumothorax. Intrapleural air may have passed directly into the peritoneal cavity through a diaphragmatic defect, or more likely via dissection through the mediastinum. Had the extrapulmonary air occurred as a result of a spontaneous pneumothorax, the lung disruption would have had to occur late in the surgical procedure or after the patient was admitted to the PACU. If it had occurred earlier in the intraoperative course, the pneumothorax would have increased in size due to the administration of nitrous oxide and positive pressure ventilation. The enlarging pneumothorax would have led to increasing peak inspiratory pressures and the patient would most likely have developed hemodynamic or gas exchange sequelae. The occurrence of a spontaneous pneumothorax late in the surgical procedure or postoperatively would be unlikely in this patient given her minimal risk factors and smooth anesthetic emergence.

Another potential cause for the pneumothorax is lung disruption as a complication of positive pressure mechanical ventilation. It occurs most commonly in patients with underlying obstructive lung disease and is associated with high airway pressures: peak inspiratory pressure, mean airway pressure, or high levels of PEEP. The peak inspiratory pressure with mechanical ventilation for this patient was 20 cm H₂O or less. The I:E ratio remained less than 1:3. The patient demonstrated no manifestations of gas trapping or intrinsic PEEP, which might have increased the potential for lung disruption. More importantly, as mentioned above, a pneumothorax was never clinically evident in the operating room, despite the use of nitrous oxide and positive pressure ventilation.

A more likely explanation for the extrapulmonary air in this patient is a laceration or tear of the hypopharynx, esophagus, or tracheal wall. Disruptions of the upper airway or esophagus, while rare, are known complications of endotracheal intubation. The areas most vulnerable to trauma during laryngoscopy include the hypopharynx and the cervical esophagus. A variety of factors are known to increase the risk of these injuries. They include the use of a beveled ETT with a stylet, the application of cricoid pressure, and the need for exaggerated manipulation of the airway with the laryngoscope to facilitate visualization of the trachea.

A small laceration of the trachea just below the vocal chords (the area of the trachea noted to be traumatized)
seems the most likely etiology for the introduction of air into the subcutaneous tissues. No evidence of hypopharyngeal injury was found. Esophageal injury was felt unlikely as the esophagus was not entered by either the laryngoscope blade or the endotracheal tube, and the esophageal stethoscope was inserted without difficulty. The induration, erythema, and possible laceration along the anterior wall of the trachea was most likely caused by the tip of the endotracheal tube itself, a result of the steep anterior angulation that was required to facilitate placement of the endotracheal tube tip into the trachea. The late onset of signs of the extrapulmonary air support this etiology. In this patient, the first signs of extrapulmonary air were not manifest until 45 min after the surgical procedure and positive pressure ventilation had been discontinued, indicating that air entrainment did not occur until after the trachea was extubated and the patient was breathing spontaneously. If the tissue disruption were located distal to the cuff of the ETT, as might occur secondary to distal tracheal laceration or alveolar rupture, air would have been introduced into the tissues outside of the trachea or in the pleural space while the patient was receiving positive pressure ventilation.

The explanation most consistent with the patient's clinical course is disruption of the tracheal proximal to the endotracheal tube cuff. In this situation, when the cuff of the ETT was inflated, the portion of the tracheal proximal to the ETT cuff, the site of the disruption, would not be exposed to increased airway pressures and therefore gas could not be insufflated into the soft tissues of the neck. Only after tracheal extubation, when the patient was breathing spontaneously and creating negative intrathoracic pressure was air entrained. The air subsequently dissected through tissue planes into the pleural space, mediastinum, subcutaneous tissues, retroperitoneum, and peritoneum.18

In summary, we report an unusual case in which a patient suffered an apparent tracheal laceration just below the vocal cords with resultant delayed-onset of pneumothorax, pneumomediastinum, pneumoperitoneum, and subcutaneous emphysema. The only risk factors that could be identified in this patient were slight decrease in neck extension and the need for cricoid pressure and a stiletted endotracheal tube to facilitate intubation. Anesthesiologists should be aware of this potential complication and understand the pathophysiology associated with its occurrence. After tracheal intubation for the patient who requires exaggerated manipulation of the head and neck and for whom passage of the endotracheal tube into the trachea is difficult, careful clinical evaluation and close postoperative observation should be provided to determine whether tracheal disruption with its attendant complications has occurred.

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