CASE REPORT

Massive surgical emphysema secondary to iatrogenic tracheal laceration

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SUMMARY

A 78-year-old woman was admitted for a revision total hip replacement following a failed dynamic hip screw placed emergently 4 months earlier. Anaesthetic management consisted of general anaesthesia with endotracheal intubation and femoral nerve block. The patient's perioperative course was unremarkable except for a promptly recognised and corrected oesophageal intubation and a short period of breathing against a closed adjustable pressure limiting valve. In recovery, following a period of hypotension resistant to fluid therapy, she suddenly desaturated, developed severe facial and upper thoracic subcutaneous emphysema and type 2 respiratory failure. She was diagnosed with bilateral pneumothoraces, pneumomediastinum, pneumopericardium and surgical emphysema. This was treated emergently with supplemental oxygen and bilateral chest drains. A CT scan demonstrated a tracheal laceration, which was managed conservatively in the critical care unit. The patient had a tracheostomy on day 5 to treat an on-going air leak and later made a full recovery.

BACKGROUND

Tracheal laceration is a rare but potentially fatal complication of endotracheal intubation. In 2008, the Royal College of Anaesthetists estimated that over 1 million people are intubated in the UK annually. It is therefore important for all clinicians to be able to recognise any complications post extubation that may occur either in recovery or in a ward environment.

English language case reports of iatrogenic tracheal laceration date back to the 1950s. Its incidence is estimated at 0.005–0.37% for single lumen endotracheal tubes (ETT) and 0.05–0.19% for double lumen ETTs.¹ Such estimations arise from elective patients intubated by experienced anaesthetists, therefore the true figure may be higher. Mortality, estimated at 22%, is therefore likely underestimated.^{2–3} Tracheal laceration can also be caused by other invasive neck procedures such as bronchoscopy, airway stenting, oesophagectomy and tracheostomy.²

CASE PRESENTATION

A 78-year-old woman was admitted electively for a revision total hip replacement. Four months previously she had undergone dynamic hip screw repair of a proximal femoral fracture, but subsequently found mobilisation increasingly restricted by pain and required home carers to assist her in activities of daily living. Relevant information from preoperative

assessment included hypertension, paroxysmal atrial fibrillation, obesity, unilateral chronic leg lymphoedema and the fact that she was a former smoker. Her medications included warfarin, furosemide, bisoprolol, losartan, omeprazole and oxycodone. Preoperative investigations were within normal limits. Her preoperative health was classed as American Society of Anesthetists (ASA) grade 2.

Anaesthesia was induced and endotracheal intubation with a size 7.0 mm internal diameter cuffed oral ETT was attempted. The initial laryngoscopic view with a Macintosh size 4 laryngoscope blade was Cormack & Lehane grade II. The first pass at intubation was promptly recognised as being oesophageal. On the second attempt, a bougie was used to achieve intubation, following which the tube was secured. An ultrasound-guided femoral nerve block was performed for analgesia. The patient bled approximately 1000 mL during surgery, dropping her haemoglobin from 134 g/L preoperatively to 75 g/L. Fluid boluses, guided by oesophageal Doppler and vasopressors were used to maintain her blood pressure. After surgery, prior to extubation, a short period of spontaneous respiration against a closed adjustable pressure limiting (APL) valve was noticed and rapidly rectified by the anaesthetists.

The patient entered recovery at 12:40 drowsy and hypotensive (blood pressure, BP 44/15 mm Hg). Owing to the intraoperative haemorrhage, this deterioration was suspected to be secondary to hypovolaemia and she was treated with blood transfusion and intravenous fluids. A urinary catheter was inserted for fluid balance monitoring. At 15:00 she reported throat pain and at 16:55, during a re-catheterisation, she became distressed with dyspnoea and severe facial swelling. Physiological observations were SpO₂ 90% on 10 L/min oxygen, BP 74/50 mm Hg and pulse rate 69 bpm.

Acute onset of facial swelling, hypoxaemia and hypotension, shortly after being re-catheterised with a latex urinary catheter and receiving a blood transfusion, led the clinical team to suspect anaphylactic shock, so the patient was initially treated with oxygen, epinephrine, intravenous fluids, hydrocortisone and chlorphenamine. Concomitantly with administering the above treatment the patient was fully examined and severe surgical emphysema was noted on her face and upper thorax. This coupled with the lack of clinical response to initial management brought the original diagnosis into doubt. Arterial blood gas analysis revealed type 2 respiratory failure and acidosis (pH 7.06, PaCO₂ 12.6 kPa, lactate 3.8 mmol/L, PaO₂ 9.6 kPa) on high-flow oxygen via a non-rebreathing mask.

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The patient was moved to the closest critical care area, an anaesthetic room, where high-flow oxygen and continuous positive airways pressure was administered. One per cent sevoflurane was given by inhalation to reduce distress without inducing anaesthesia. Rapid chest radiography available immediately in theatre confirmed surgical emphysema, and also showed bilateral tension pneumothoraces and pneumomediastinum (figure 1). Bilateral large bore chest drains were inserted and invasive arterial and central venous pressure monitoring were instituted before transfer to the intensive care unit for continued observation.

After resuscitating and stabilising the patient, a CT scan of the neck was performed, which showed a clear 3 mm tear in the posterior wall of the trachea 5 cm superior to the carina, extensive surgical emphysema, pneumothoraces, pneumomediastinum and pneumopericardium (figure 2). A fibreoptic nasal endoscopy showed swollen lateral pharyngeal walls and epiglottis. On the basis of strong clinical features and an obvious laceration visible on CT scan, a diagnosis of tracheal laceration was made.

On day 3, despite some improvement, there was a persistent air leak. CT thorax confirmed that the laceration remained. After multidisciplinary discussions involving intensive care, ear nose throat and cardiothoracic colleagues, a decision was made for conservative management. A tracheostomy was placed surgically on day 5 under general anaesthesia. Prior to surgery an ETT was placed awake under fibreoptic guidance, where the diagnosis of tracheal laceration was confirmed.

The patient's recovery was complicated by an episode of atrial fibrillation and a hospital-acquired pneumonia. Despite this, with supportive critical care management, she was successfully decannulated 19 days post-tracheostomy and discharged home 9 days later. Unfortunately, the tracheal laceration meant she required prolonged nasogastric feeding and lost a significant amount of weight. Additionally, although the revision hip surgery reduced her pain, she developed a critical illness myopathy, hindering her ability to engage with postoperative rehabilitation, resulting in a prolonged hospital admission and an inability to mobilise independently on discharge. Community physiotherapy was arranged aiming to further improve her functional status after discharge.

DISCUSSION

The evidence base for management of iatrogenic tracheal laceration is sparse and consists of grade 3 evidence. Lacerations

Figure 1 Chest radiograph showing widespread surgical emphysema of chest and neck, bilateral pneumothoraces and pneumomediastinum.

Figure 2 CT image of the neck. Extensive surgical emphysema with gas dissecting the thoracic muscle planes and pneumomediastinum. Posterior tracheal laceration indicated by arrow.

commonly affect the distal third of the trachea, are typically linear, can be up to 13 cm long and may also extend into the bronchi.¹⁻³

Typically, the reported intubation was easy and performed by an experienced anaesthetist, but several common themes and suggested mechanisms have emerged in case reports (table 1).^{2-4 7} Cuff overinflation usually affects the junction of the pars membranacea and cartilaginous rings, while intubation aids more commonly affect the anterior trachea. Women are at increased risk, possibly due to having a weaker pars membranosa and narrower trachea.³

Clinical features include subcutaneous emphysema, respiratory distress, pneumothoraces, haemoptysis and dysphonia, and symptoms typically start within 12 h.³ Time to diagnosis is usually 1–5 h, but some authors have found that diagnosis can be delayed in up to 66% of cases.^{1 3} Bronchoscopic evaluation is widely considered the gold standard for diagnosis, but tears may be visible on CT and plain chest radiography may provide rapid information about the nature and severity of complications. The optimal treatment strategy for iatrogenic tracheal laceration is debated.² Surgical management has historically been advocated but more recently, evidence for conservative management has been accruing.

Earlier case reports and series support surgical repair. This normally comprises a single layer of sutures, sometimes with a covering material, usually attempted via thoracotomy or less frequently via a transcervical approach. It is recommended for larger lesions (>4 cm), late diagnoses, massive air leaks, mediastinal and pleural breeches, progressive symptoms or difficulty maintaining ventilation.¹ In 2011 Welter *et al* described a new technique of endotracheal repair via a modified rigid bronchoscope with optical needle holder, reporting lesion closure in 3 of 4 cases. The technique has much potential, but also poses several challenges, and requires further evaluation before being more widely used.⁵

Conservative management, comprising humidified oxygen, antibiotics, chest drains and sometimes a cuffed endotracheal or tracheostomy tube to cover the defect, is increasing in popularity. Jougon *et al*⁶ published a case series where 7 patients were treated conservatively and 7 surgically with 1 death out of 14 in the surgical group. A conservative management strategy has been suggested in case of small lesions (<1–4 cm), early diagnosis, no pleural or mediastinal breach, insignificant or non-progressive symptoms or in those patients unsuitable for surgery.^{3 6}

Table 1 Factors associated with tracheal laceration

Patient factors	Mechanical factors	Anaesthetic factors
<ul style="list-style-type: none"> ▶ Female gender ▶ Age >50 years ▶ Tracheal wall weakness: steroids, malformation, COPD, tumours, tracheomalacia and inflammation of tracheobronchial tree ▶ <160 cm tall (some evidence) ▶ Coughing against blocked ETT 	<ul style="list-style-type: none"> ▶ Inappropriately large ETT size ▶ Misuse of stylet/bougie ▶ Cuff over-inflation ▶ Endotracheal tube tip, stylet or bougie impinging in a mucosal fold ▶ Repositioning of ETT without deflating cuff 	<ul style="list-style-type: none"> ▶ Inexperience ▶ Multiple vigorous attempts ▶ Possible link to use of nitrous oxide (N₂O) ▶ Double lumen tubes ▶ Intubation: emergency or predicted difficulty

COPD, chronic obstructive pulmonary disease; ETT, endotracheal tubes.

Mortality is estimated at 22%, commonly due to mediastinitis and sepsis. Recent publications note death being more common in men, those with a delayed diagnosis, emergency patients and surgically-treated patients, perhaps reflecting more severe injuries.³

We speculate that our case was triggered by the bougie and exacerbated by the episode of high pressure from breathing against the closed APL valve. It is possible that the pneumothoraces developed slowly in recovery manifesting only as refractory hypotension caused by the high-intrathoracic pressure and decreased venous return. This case serves a valuable lesson: due to the severe facial swelling, hypoxia and latex exposure, we started anaphylaxis treatment, however, early re-evaluation allowed the diagnosis to be revised minutes later as the surgical emphysema became apparent. Tracheal laceration can potentially lead to an air leak that develops slowly, with a spectrum of signs, but may still later decompensate suddenly with respiratory difficulty and acute facial swelling. Despite its relative rarity, tracheal laceration should always be considered in recently intubated patients, and in those who are being ventilated. In these patients, increasing the ventilatory pressure in order to overcome the respiratory compromise could worsen the air leak and risk a critical reduction of circulatory return causing cardiac arrest.

Our case did not clearly meet either the surgical or conservative management criteria mentioned above. The initial severity of the patient's complications could be judged to warrant surgical intervention, however, the lesion was small and diagnosed promptly. There were no difficulties with ventilation, and

supportive treatment led to an observable improvement in her clinical state. Additionally, the laceration was clearly visible on CT, and therefore it was felt that early bronchoscopy was unnecessary, however, this is not always the case. A grading system based on the location of the injury and any associated complications has been advocated to help determine management strategy of this condition but, at the time of writing, all case series have been done on small numbers of patients with no present consensus as to when to operate.⁸ On balance, the multidisciplinary team concluded that due to the patient's frailty and comorbidity, it was in her best interest to pursue a conservative management strategy. Despite her relatively poor premorbid health status, initially severe symptoms of tracheal laceration, and both pleural and mediastinal breeches resulting in bilateral tension pneumothoraces, the patient survived with conservative management.

This case suggests that conservative management may be used successfully in scenarios where neither a conservative nor surgical strategy is clearly indicated.

Contributors SC participated in literature search, production of the first draft of the case report, revisions of the report, approval of the final draft and acting as the corresponding author. HR was involved in devising the initial concept for the case report, obtaining consent from the patient, literature search, production of the first draft, obtaining radiological images, revisions of the report and approval of the final draft. AW took part in literature search, revisions of the initial draft of the case report, provision of specialist anaesthetic expertise in evaluating the report and approval of the final draft. GF participated in literature search, revisions of the initial draft of the case report, provision of specialist anaesthetic expertise in evaluating the report and approval of the final draft.

Competing interests None.

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Learning points

- ▶ Iatrogenic tracheal laceration after endotracheal intubation is a rare but potentially fatal complication. Prompt recognition and treatment ensure positive patient outcomes. Consider tracheal laceration as a cause of dyspnoea, haemoptysis and surgical emphysema up to 24 h postextubation, especially in elderly female patients.
- ▶ Owing to the risk of mediastinitis, broad-spectrum antibiotics should be given for at least 1 week after the lesion has been identified.
- ▶ There are no best practice guidelines for the management of this condition. Published reports have previously favoured conservative management for small tears (<4 cm), minimal air leaks and the absence of pleural or mediastinal breaches. Prompt surgical repair should be considered for cases not fulfilling these criteria.
- ▶ Our case suggests that conservative management can be considered even if there is a pleural or mediastinal breach.

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