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CASE REPORT

HIGH PRESSURE VENTILATION INJURIES FROM SUPRAGLOTTIC AIRWAY DEVICES: A REPORT OF TWO CASES

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ABSTRACT:

Supraglottic airways (SGAs) can be life-saving devices allowing for oxygenation and ventilation, both as a primary airway management technique as well as a rescue device. However, these devices also have a risk of high-pressure ventilation injuries, including pneumothoraces, pneumomediastinum, and massive subcutaneous air. We present two cases of patients with high-pressure ventilation injuries after the placement of SGAs in the prehospital setting. Clinicians should be aware of the risk of high-pressure ventilation injuries with SGAs, especially in older patients, those with a higher BMI, those with preexisting airway trauma, and those with high-pressure ventilation requirements.

INTRODUCTION:

Supraglottic airways (SGAs) are potentially life-saving devices that allow for oxygenation and ventilation. These devices are invaluable as rescue airway devices in patients who cannot otherwise be intubated (Apfelbaum et al., 2022; Gordon et al., 2018). Additionally, SGAs are increasingly used in primary airway management in the out-of-hospital setting, especially in cases of cardiac arrest (Benger et al., 2020; Lee et al., 2022). However, these devices have risks. In addition to the well-known risks of aspiration and ineffective ventilation (Gordon et al., 2018; Simon & Torp, 2022), clinicians should be aware of the risk of high-pressure ventilation injuries, including pneumothoraces, pneumomediastinum, and massive subcutaneous air (Muszalski et al., 2019). Although rare, this is a known complication of SGA placement. Here, we present two cases of patients with high-pressure ventilation injuries after the placement of SGAs in the prehospital setting.

CASE 1:

An 85-year-old man with a history of colon and pancreatic cancer, as well as atrial fibrillation on Plavix, presented to the emergency department after a fall. On the day of presentation, the patient cried out at home, collapsed, and fell down an unknown number of stairs. He sustained obvious head and facial trauma. His family called emergency medical services (EMS), and on their arrival, they attempted to intubate the patient. After two unsuccessful attempts, the paramedics noted blood in the airway. Therefore, intubation attempts were aborted, and a King supraglottic airway (SGA) was placed. Upon arrival to the emergency department (ED) he was noted to have extensive subcutaneous air in the neck and face. On chest radiograph (Figure 1) the patient had bilateral pneumothoraces and subcutaneous air.

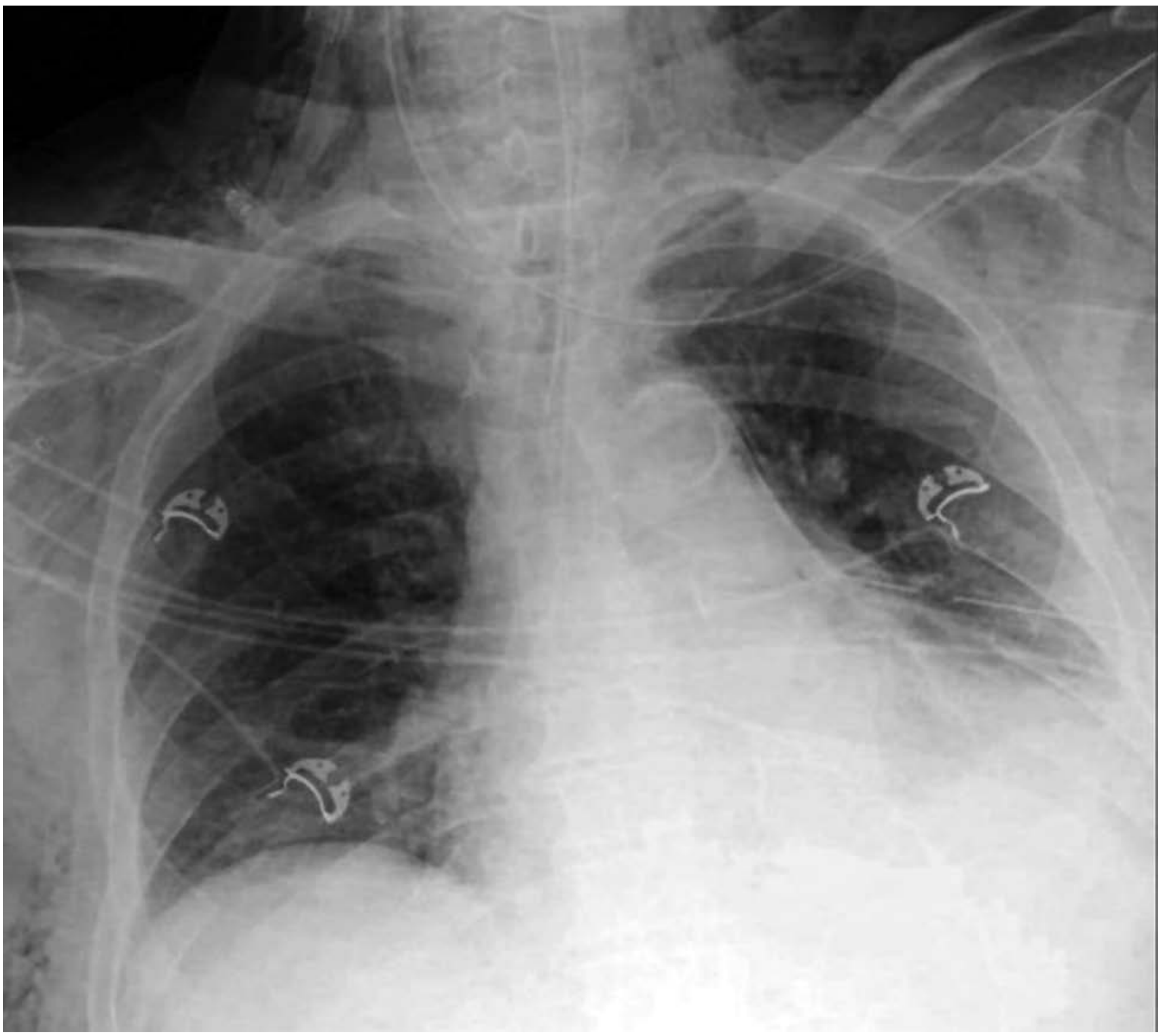

Figure 1. Chest radiograph after intubation and placement of a left sided chest tube demonstrating massive subcutaneous emphysema in the chest and neck.

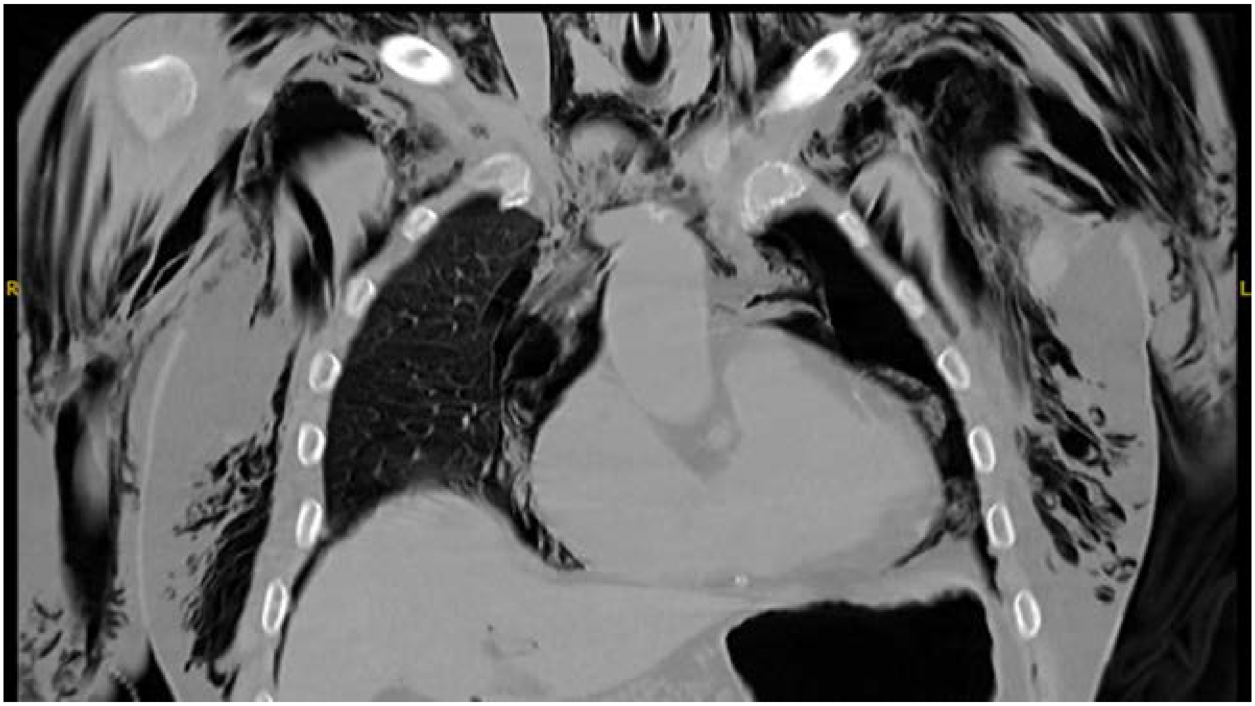

Figure 2. Computed tomography highlighting the massive subcutaneous emphysema and a residual anterior left pneumothorax.

The ED team promptly placed bilateral chest tubes for thoracic decompression. He was then intubated on first attempt by the ED team with videolaryngoscopy after blood was suctioned from the airway. He had non-contrast computed tomography (CT) showing bilateral pneumothoraces, pneumomediastinum, pneumocardium (Figure 2), and pneumoperitoneum as well as an intracranial 3 cm bleed vs mass to the left basal ganglia with mass effect.

The critical care transport (CCT) team was contacted for transport to a tertiary care center for surgical evaluation. The CCT team arrived to find the patient intubated with diminished bilateral breath sounds but symmetrical chest expansion. He had extensive subcutaneous air to the face, neck, and chest, despite his bilateral chest tubes being placed to suction. His ventilator was set with pressure control ventilation, with an inspiratory pressure of 15 cmH_2O, a positive end expiratory pressure (PEEP) of 5 cmH_2O, with resultant tidal volumes (TV) of 400 mL, a rate of 16 breaths per minute, a fraction of inspired oxygen (FiO_2) of 30%. His oxygen saturation was 100%. His chest tubes were maintained on 20 cmH_2O of suction, and he was transported uneventfully.

CASE 2:

An 84-year-old woman with a past medical history of hypertension, hyperlipidemia, acid reflux, and previous stroke was found unconscious in her nursing home. The patient was noted to have diarrhea the day prior. The nursing home staff called 911, and the EMS team arrived to find the patient with agonal breathing and a systolic blood pressure of 80 mmHg. The paramedics attempted to intubate, obtaining a Grade 1 view but unable to pass the endotracheal tube. They therefore placed a laryngeal mask airway (LMA). After attempting to ventilate the patient through the LMA, the EMS team noted substantial swelling developing over the patient's chest, neck, and face. They were concerned this rapid swelling was an allergic reaction. The patient was then rapidly transported to a local emergency department.

In the ED the swelling was believed to be subcutaneous emphysema, and the ED staff replaced the LMA with an endotracheal tube. A chest radiograph demonstrated bilateral tension pneumothoraces, resulting in her hypotension, along with massive subcutaneous air (Figure 3).

The ED team then placed bilateral chest tubes with rushes of air. Despite improvement in her profound hypotension from the bilateral thoracostomies, the patient remained hypotensive. She was started on norepinephrine at 7.5 mcg/min, and the CCT team was called for transport to tertiary care.

The CCT team arrived to find an older woman intubated on the stretcher with clear and equal lung sounds bilaterally. They noted subcutaneous air diffusely throughout her upper chest, neck, and face. The bilateral chest tubes were connected to wall suction without any bubbling or tidaling noted. The chest radiograph confirmed chest tube placement with a slightly shallow drain port in subcutaneous tissue (Figure 4).

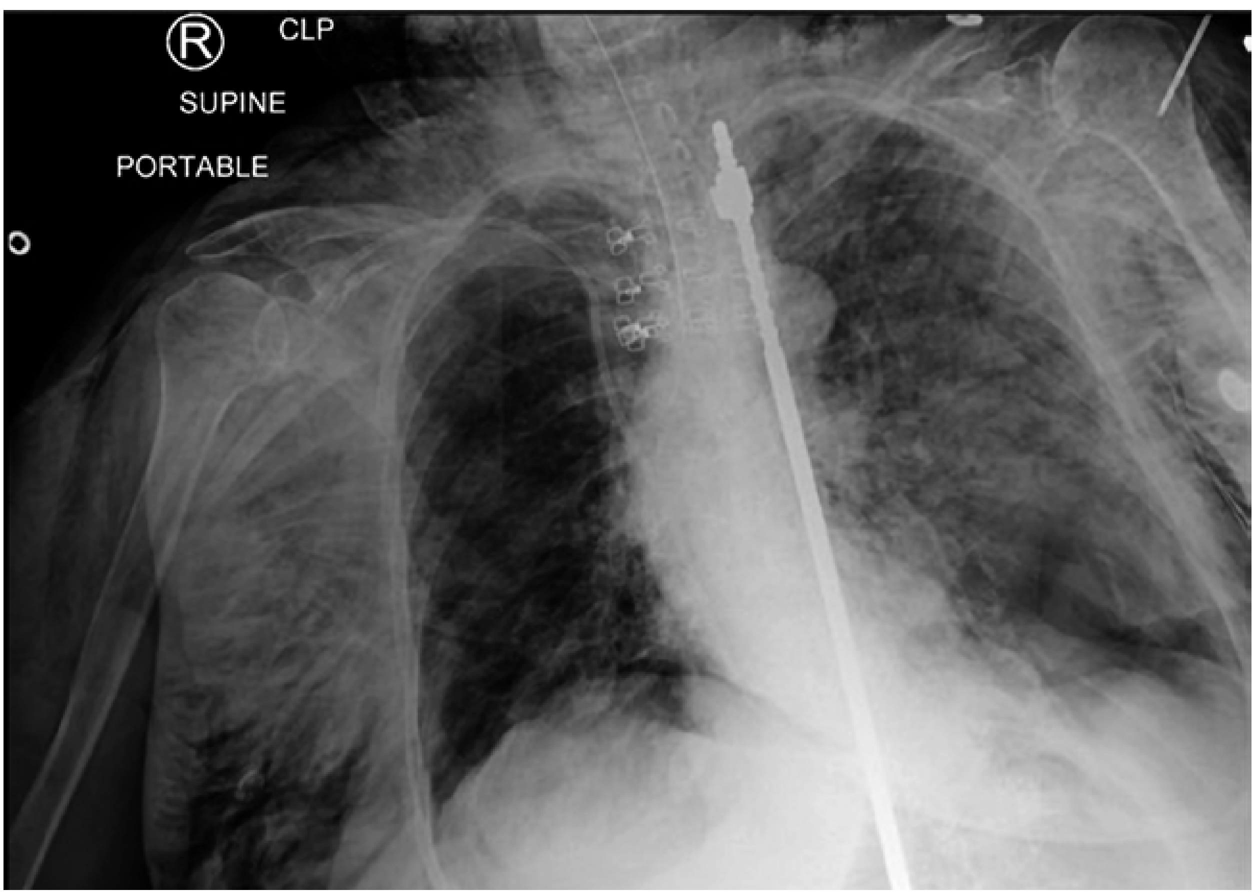

Figure 3. Chest radiograph demonstrating bilateral pneumothoraces with tension, resulting in a compressed mediastinum, and massive subcutaneous emphysema.

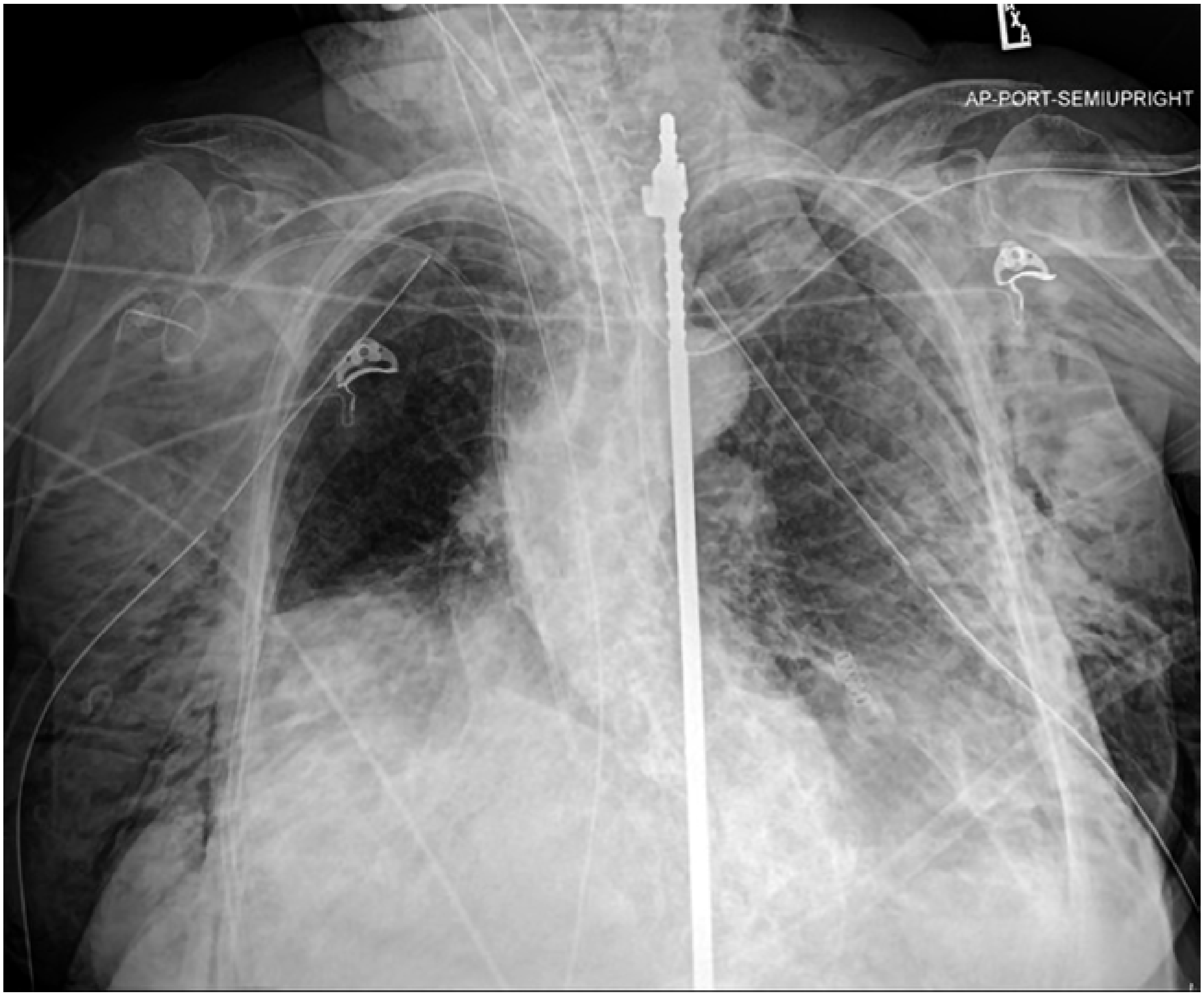

Figure 4. Chest radiograph after placement of bilateral chest tubes and persistent subcutaneous emphysema of the chest and neck.

Her vitals were notable for an oxygen saturation of 82% with a nadir of 79% while awaiting transport. She was ventilated with volume control ventilation with TV of 300 mL, a rate of 28 breaths per minute, a PEEP of 3, and FiO_2 90%. With these settings and the chest tube drainage, her peak inspiratory pressure was only 19 mmHg. The CCT team continued the same ventilator settings and with her chest tubes to suction. She was transported safely to a tertiary care center for surgical evaluation.

DISCUSSION:

Supraglottic airways (SGAs) are an important instrument in airway management. In both the cases presented, the SGA served as a life-saving instrument in patients who could not otherwise be intubated. However, both patients suffered adverse events, likely related to the placement of the SGA. Once predominantly used in the operating room, over the last 30 years SGAs have been increasingly used in the prehospital setting (Gordon et al., 2018; McNarry & Patel, 2017; Simon & Torp, 2022). The SGA allows for oxygenation and ventilation with blind placement just superior to the glottic opening (Simon & Torp, 2022), and they can be placed quickly and easily without the use of a laryngoscope. In addition to serving as a rescue device, SGAs are increasingly used in out of hospital cardiac arrest. Literature has shown a decreased time to placement as compared to intubation, with no decrement in clinical outcomes (Benger et al., 2020; Lee et al., 2022; Tjerkaski et al., 2022).

This ease of placement can also be beneficial in situations where there have been multiple attempts to place an endotracheal tube (ETT) without success (Gordon et al., 2018; Heidegger, 2021). SGAs are recommended as a rescue device in the 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway (Apfelbaum et al., 2022). In both of the cases reported, the EMS team encountered a patient in the field who required intubation but could not be intubated by a direct laryngoscopy approach. In both cases, the use of the SGA may have been lifesaving to provide oxygenation and ventilation, although both patients also sustained untoward effects.

Despite the ease of placement and the common use, SGAs have inherent risks. Since the insertion of the SGAs is largely blind, there are risks of oropharyngeal trauma, bleeding, swelling, and infection (Gordon et al., 2018). The position does not create a seal to protect the airway and lungs, as is found in endotracheal intubation. While the risk of aspiration and gastric inflation with SGAs are well-reported (Gordon et al., 2018; Simon & Torp, 2022), the risks of pneumothorax, pneumomediastinum, and subcutaneous emphysema are known, but are less well-established. By placing this device superior to the glottic opening, the airway pressures needed to ventilate the patient can also be applied to structures that normally are not exposed to positive pressure. This can cause air to be forced into the tissues, especially in the setting of difficult ventilation requiring higher airway pressures. The existing literature does not report massive subcutaneous air with prehospital primary SGA placement; the only reports are with SGA placement after failed intubation attempts, consistent with the present cases. However, there are reports of SGA-associated pneumothoraces and pneumomediastinum in the peri-operative literature (Choy & Pescod, 2007; Gianesello et al., 2019; Michalek et al., 2015). While the patient populations differ, these reports support the recognition of pressure ventilation injures with SGA use.

The risk of subcutaneous air secondary to SGA placement is known to be higher in patients with a higher body mass index (BMI), those who are older than age 46 (Michalek et al., 2015), previous laryngoscopy attempts that have caused trauma (Michalek et al., 2015), and ventilating with high airway pressures (Atalay et al., 2015), In both of the cases presented, the patients were of older age and had unsuccessful laryngoscopy attempts with trauma. Our transport group previously published a case of a 52-year-old woman with a high BMI and oral trauma from a seizure who developed massive subcutaneous emphysema after placement of a King LT (Ambu Inc., Columbia, MD) supraglottic device (Muszalski et al., 2019). Similarly, this previously reported patient had several of the risk factors for subcutaneous emphysema after an SGA placement. Existing case reports implicate both the laryngeal mask airway and King LT. It is unknown whether the risks of high-pressure ventilation injuries differ among the various SGA devices.

To alleviate subcutaneous air, small incisions can be made into the skin just inferior to the clavicles (Johnson et al., 2014). Alternatively, angiocatheters may be inserted into the subcutaneous space to allow air to escape, although restoration of anatomic landmarks will take some time. If air has migrated into the pleural space resulting in pneumothorax, the patient will likely require a tube thoracostomy. Pneumomediastinum is usually treated conservatively with pain control, administration of 100% oxygen, and monitoring (Kouritas et al., 2015).

Clinicians need to be aware of the risks of massive subcutaneous air secondary to SGA placement as it can be a lethal complication for their patient. Massive subcutaneous air can distort airway anatomy leading to the inability to place any airway device. Air in the chest, either as a tension pneumothorax or massive pneumomediastinum, can put pressure on the great vessels and lead to obstructive shock. Additionally, subcutaneous swelling can be mistaken for an allergic reaction, as it was in the second case reported here. Recognition of the actual etiology of swelling is essential to provide the appropriate interventions. Awareness of the potential complications may not only mitigate the risks of these complications but also lead to quicker reaction if they occur.

CONCLUSION:

SGAs are lifesaving devices and are indicated for patients who cannot be intubated. Although the risks of aspiration and ineffective ventilation are known, the risks of high-pressure ventilation injures have been underappreciated. Clinicians should be aware of this risk, especially in older patients, those with a higher BMI, those with preexisting airway trauma, and those with high pressure ventilation requirements. These risks should not preclude the use of SGAs, but awareness of the issue will result in improved understanding and prompt management when they occur.

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