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Pneumothorax following shoulder arthroscopy under combined regional and general anaesthesia—A case report

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ABSTRACT

INTRODUCTION: Pneumothorax is a most rare intraoperative event but jeopardise safety. Risk factors for its occurrence should be acknowledged and it should be considered in cases of unexpected deterioration of oxygenation that not respond to standard management to improve oxygenation.
PRESENTATION OF CASE: We describe a patient with mild obesity and recent shoulder trauma scheduled for elective arthroscopy under combined interscalene block and general anaesthesia in the beach chair position. The block was performed with ultrasound guidance in accordance with the departmental routines and before the induction of general anaesthesia. The patient experienced low saturation shortly after administration of general anaesthesia. A thoracic ultrasound was performed in order to rule out pneumothorax and recruitment manoeuvres was done based on the suspicion of atelectasis. Surgery was commenced under pressure controlled ventilation and saturation was kept around 90 at FiO2 1.0 after recruitment manoeuvres. An initial postoperative lung X-ray on the operating table showed subcutaneous emphysema but no pneumothorax. A postoperative CT-thorax, patient still intubated, showed an extensive pneumothorax that was treated with pulmonary drainage. Patient had subsequently an uncomplicated postoperative course.
DISCUSSION: We can not state "whom to blame", the interscalene block, intubation and pressures assisted ventilation, recruitment manoeuvres, or surgery? In this paper we discuss possible causes that should raise the suspicion around pneumothorax in patients exhibiting unexpected low saturation perioperatively.
CONCLUSION: Compromised oxygenation during surgery that not respond to recruitment should raise suspicion about pneumothorax.
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1. Introduction

Pneumothorax, air entrainment into the pleura space compromise oxygenation and may also impact venous return and thus cause circulatory instability. The degree of impaired oxygenation may vary. Pneumothorax should however be considered in patients showing unexpected deterioration in oxygenation and risk factors for its occurrence should be acknowledged. Lung auscultation and frontal X-ray not sufficient to exclude a pneumothorax. We describe a patient with pneumothorax shown on postoperative CT-scan of the thorax following shoulder arthroscopic rotator cuff repair performed under combined interscalene plexus block and general anaesthesia in a patient with multiple risk factors.

2. Case report

A 72 year old man with BMI 38.4, sleep apnoea and night time CPAP, gout and benign prostatic hyperplasia scheduled for surgery on his left shoulder because of rotator cuffed syndrome. He had previously been operated for spinal stenosis and had also had arthroscopic surgery in both shoulders twelve years ago. He was assessed as being vital and healthy, a previous echocardiogram from January 2015 had shown normal heart function but with a minor aortic insufficiency. During the waiting time for surgery he fell in a stairway and hit his right shoulder giving him a fracture in fossa glenoidale and partial ruptures in subscapularis and supraspinatus. These injuries lead to frequent luxations of the shoulder which the patient painfully could relocate himself. Because of the trauma and more intense symptoms from the right shoulder he planned surgery on his left shoulder got exchanged for suturing the rotator cuff on his right shoulder instead. Upon arrival to the surgery department the patient was in a good mood. The patient was circulatory stabile. Respiratory wise he had a saturation of 92% measured by standard pulsoxemitry, earlier in the

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morning at the ward it was at 93%. The low saturation was thought of to be due to atelectasis from the overweight. He was assessed as having a difficult airway. The major part of his overweight was on his upper-body giving him a wide and very short neck and a small chin. The ultrasound probe for the plexus block (interscalene) gave a good view of the nerves allowing for needle placement in-plane. The most difficult part of the block was the patient's skin being hard to puncture with the ultrasound needle and thus a pre-puncture had to be made with a larger, sharper needle. The needle was easily spotted and the local anaesthetic was administered with good effect. After the block was administered the patient was preoxygenated with low levels of pressure support increasing the saturation to 100%. The patient received general anaesthesia with rapid sequence induction and intubation with a video laryngoscope (STORZ) without any desaturation.

Initially there was no problem with ventilation, the patient was on pressure control with volume guarantee and we were able to reduce to minimal flow on the ventilator with good saturation. Shortly after the start of surgery the nurse anaesthetist called to notify that the patient saturation had dropped to 91% and that the ventilator needed high top pressures to get sufficient tidal volumes. It was assessed that the patient had a shallow anaesthetic depth and was not breathing in synchrony with the ventilator. He was switching over to manual ventilation and adequate tidal volumes was easily restored. Manual lung requirement was performer and the end-tidal sevoflurane increased. He was put back on pressure controlled ventilation with volume guarantee and ventilation was stabilised. After some further time oxygen saturation once more started to decrease and FiO2 was increased. Lung auscultation revealed breath sounds bilaterally but better on patients left. The tracheal tube which was secured relatively deep, on 26 cm, was adjusted to 23 cm resulting in improved breath sounds but with no major improvement in saturation. A new lung recruitment manoeuvre, this time with the ventilator (pressure control, breathing frequency put on 5/min, and PEEP gradually raised to a top pressure of 30 cmH2O) was performed. This improved compliance from 30 to 65 ml/cm H2O and again improved saturation but just briefly. The patient now had a saturation around 90% and FiO2 1.0 and no clear breath sound were heard on right side. Surgery was completed within 30 min without further deterioration of patient's respiratory status. Thoracic ultrasound and then chest X-ray were performed immediately post-surgery, patient still on operating table and intubated on the suspicion of a pneumothorax. The emergent ultra-sound was inconclusive and X-ray showed extensive subcutaneous emphysema but did not confirm any clear pneumothorax. The patient could not be taken off the ventilator due to the high oxygen demand and was transported still anaesthetised and intubated for a CT-scan. The thoracic CT confirmed a large pneumothorax. Patient was transferred to the ICU and a traditional chest-drain was inserted. Oxygenation rapidly improved and the patient could after a couple of hours be extubated and had a further uncomplicated course. The drain was removed after 2 days.

3. Discussion

Our patient had an unexpected intraoperative deterioration in oxygenation that did not respond adequately to lung recruitment. The suspicion of pneumothorax was raised but following adjustment of the tube position and intraoperative lung auscultation it was initially rejected. Frontal ultra-sound as well as an acute frontal X-ray failed to confirm the diagnos that was later confirmed on CT.

Intraoperative pneumothorax is a rare event but should be acknowledged in situation of unexpected decrease in oxygenation that did not respond to lung recruitment. We can not state "*whom to blame*"; there are several plausible explanations for the development of pneumothorax in the present case. The most prevalent factors include: needle injuries associated with the performance of the upper extremity block, external pressure on the upper pleura dome associated with the shoulder arthroscopic procedure, thermal forces induced by the use of diathermia, baro-trauma caused by airway pressure associated to intubation and ventilation, or lung recruitment. Patient factors include: smoking habits, lung disease (COPD, emphysema, cancer), prior history of pneumothorax, history of recent thorax trauma and rare diseases such as alpha-I-antitrypsine deficiency should also be taken into account.

4. Upper extremity block and the risk of pneumothorax

Pneumothorax is one of side effects that may be seen, albeit rarely, associated with interscalene block. The use of ultrasound help visualising the needle tip reducing but not eliminating the risk [1,2]. Mandim et al. suggested that a high pleura dome e.g. caused by smoking may contribute to needle injury. Montoro et al. suggest that merely short loss of needle tip visualisation could be a possible explanation [3]. There are several papers reporting a reassuringly low incidence associated to ultra sound guided blocks especially when performed of trained anaesthesiologists [4,5]. Bhatia et al. summarised the 3 major factors that increase risk of pneumothorax associated to ultra-sounded guided upper extremity block; ***operator factors***, loss of visualisation of the needle tip, ***technical factors,*** probe and plane and hydro-visualisation, and ***patient factors such as*** lung disease, smoking, emphysema and obesity [6]. Abell and Barrington published a case report in 2014 data collected from the International Registry of Regional Anesthesia (IRORA), a multi-centre registry that systematically and uniformly collects information from patients who receive peripheral nerve blockade [7,8]. They estimated the risk of pneumothorax associated with ultrasound-guided supraclavicular block to be 0.4 per 1000 but with a huge 95% confidence interval, 0.01–2.3 per 1000 blocks. They also addressed needle visualisation in terms of the relative importance in reducing the risk of pneumothorax. Neal recently published an updated systematic review around the topic of ultrasound guidance for patient safety. The review showed ultrasound guidance to have a favourable effect in reducing the risk of local anaesthesia toxicity, as well as reducing but not eliminating the risk of pneumothorax [9].

5. Subcutaneous emphysema, pneumomediastinum and pneumothorax related to shoulder arthrospcopy, the surgical procedure

There are rare reports of pulmonary complications in arthroscopy of the shoulder where the complication has been suggested to possibly be related to the arthroscopic procedure itself. Lee et al. described two cases of subcutaneous emphysema and tension pneumothorax [10]. Lau went on to described a patient that developed subcutaneous emphysema and pneumo-mediastinum associated with arthroscopic surgery of the shoulder and raised the suspicion that it may have had an association to the intraarticular shaving [11]. Dietzel and Cuillo described 4 cases of pneumothorax following a shoulder arthroscopy under general anaesthesia [12]. All four patients had risk factors but a relation to the surgical procedure could not be excluded. Calvisi et al. described a case of pneumothorax associated with arthroscopy performed under local regional anaesthesia [13]. They emphasise the importance of adequate intended equipment such as pumps and suction devices in order to minimising tissue air entrainment. Pneumothorax has also be seen associated to breast reconstruction [14]. Possibly related to pleura trauma associated to stretch forces, diathermia or accidental needle injury during placement of the local anaesthesia [15].

6. Pneumothorax associated to general anaesthesia

Rare cases of pneumothorax potentially associated to anaesthesia has been described since long. Christian et al. describe a case with pneumothorax following a seemingly uncomplicated anaesthesia, intubation and maintenance with inhalation and oxygen in nitrous oxide [16]. They discuss the main causes: air way forces, bronchus intubation and patient risk factors, smoking and lung disease. Rastogi and Wright describe a case of pneumothorax and discuss airway and transpulmonary forces that may have caused the baro-trauma [17]. They suggest that a pressure difference between trachea and pleura so called transpulmonic pressure of approximately 60 mm Hg may cause baro-trauma. There are also more recent reports of pneumothorax associated with general anaesthesia, even during spontaneous breathing and with the use of a laryngeal mask airway [18]. The author speculate if intense coughing could have been a causal factor. Difficult intubation and the use of airway exchange catheters, or any other assisted oxygenation tool with pressurized gas may of course also cause high pressure *trans*-pulmonary cause and subsequent baro-trauma [19].

7. Patient factors

Patient factors must also be taken recalled. History of smoking, lung disease, and recent thoracic trauma are all obvious risk factors. Patient may also have a "spontaneous" pneumothorax, possibly induced by perioperative trauma/anaesthesia and stress [20].

8. Diagnosis of perioperative pneumothorax

Lung auscultation is useful for the identification of tube placement and major pneumothorax but is not an optimal technique to verify minor pneumothorax [21] Frontal ultra-sound and X-ray have not a 100 sensitivity to detect a pneumothorax [22,23]. Ultra sound may have a higher sensitivity but CT-scan still optimal technique for diagnosis is CT-scan.

9. Summary/conclusion

We cannot provide any firm and explicit explanation to our case, why the patient developed a pneumothorax. He had several risk factors, x-smoker, obesity, and a rather recent thoracic trauma a week ago. He had an interscalene block managed with ultrasound guidance that reduce but no eliminate the risk for pneumothorax. Furthermore, he was intubated with rapid sequence induction and he was provided lung requirements in order to improve oxygenation. A suspicion for a pneumothorax was raised but not confirmed on initial frontal ultra-sound and acute frontal X-ray but subsequently confirmed on postoperative CT.

10. Take home

Compromised oxygenation during surgery should raise suspicion about pneumothorax. Pneumothorax may not be visualised on frontal ultrasound, nor on X-ray.

There are several factors that may contribute to the development of pneumothorax that should increase the efforts to exclude its occurrence;

- Needle punctures, upper extremity block, infiltration associated to surgery.
- Surgery related forces; diathermia in close proximity to the pleural space, any external force that may cause changes in the pleural pressures, e.g. shavers, profound pressure associated breast implant, reconstruction etc.
- Anaesthesia-associated factors; any "accidental" high peak bronchial pressures e.g. caused by bronch intubation or use of a tube-exchange catheter, especially with continuous oxygen flow, and possibly enforced lung recruitment in a at risk patient.
- Patient factors; smoking and lung disease, COPD/emphysema, lung cancer, history of pneumothorax, recent thoracic trauma.
- Lung auscultation is not sufficient for identification of pneumothorax.

Conflicts of interest

None of the authors have any conflict of interest related to the present Case Report. The manuscript is compiled and written supported by funding from the department, no external funding has been received.

The CARE criteria have been followed

The patient was explicitly informed and gave consent to the anonymous presentation of the event.

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Ethical approval

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Consent

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Author contribution

All authors have contributed equal to the writing/preparation of this case report.

Guarantor

NA.

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