

Spontaneous pneumothorax after shoulder arthroscopy under general anesthesia: a case report

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Abstract

A woman in her early 70s presented with a right fifth rib fracture along with left scapular body and glenoid fractures resulting from a traffic accident. She had no history of lung disease. The patient underwent multi-incisional video-guided arthroscopic fracture reduction and screw fixation in the right lateral decubitus position under general anesthesia, and surgery was followed by chest tube insertion. Left-sided pneumothorax was found during routine postoperative radiography despite the absence of relevant symptoms or signs such as hypoxia, chest pain, or respiratory difficulty. We herein report this unusual case with a brief literature review.

Keywords

Anesthesia, arthroscopy, complication, orthopedic procedure, pneumothorax, trauma.

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Introduction

Pneumothorax refers to a condition in which air fills the pleural space. The pleural space maintains negative pressure throughout the respiratory cycle, and the introduction of air into this space spontaneously or due to trauma or any other cause leads to the development of pneumothorax. The onset of pneumothorax may be fatal depending on the pathogenesis. The causative factors can be

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classified into patient-related factors, anesthesia-related factors, and surgery-related factors.^{1,2}

We herein present a case of pneumothorax that was incidentally discovered during chest radiography in the postanesthesia care unit (PACU). The patient had undergone arthroscopic glenoid fracture repair in the right lateral decubitus position under general anesthesia. Despite normal peripheral oxygen saturation and no abnormal symptoms such as dyspnea, the pneumothorax was detected during postoperative radiographic examination of the surgical site. Along with this case, we also present a review of the literature. On the basis of our findings, we recommend that clinicians consider the possibility of pneumothorax as a complication following shoulder arthroscopic-guided fixation in patients with chest trauma and exclude nitrous oxide from the general anesthesia protocol.

Case report

A woman in her early 70s was admitted for surgical treatment of subarachnoid hemorrhage (SAH) and fractures of the left distal radius, right sacrum, superior ramus of the right pubis, left scapular body, and glenoid resulting from a traffic accident 10 days earlier. Her height was 155 cm, weight was 70 kg, and body mass index was 29.14 kg/m². She was a nonsmoker and had no history of lung disease. However, she had hypertension (treated with losartan [an angiotensin II receptor blocker] and hydrochlorothiazide [a thiazide diuretic]) and diabetes mellitus (treated with insulin; her hemoglobin A1c concentration was 9.1%). The patient's vital signs in the emergency department (ED) were as follows: blood pressure (BP), 172/92 mmHg; heart rate, 69 beats/min; and body temperature, 36.6°C. An electrocardiogram (ECG) showed sinus rhythm and nonspecific T-wave abnormalities. Chest radiography

at the time of arrival in the ED and 1 day before surgery revealed no definitive evidence of active consolidation in either lung field; however, a right fifth rib fracture was present (Figure 1). Arterial blood gas analysis revealed a pH of 7.35, PaCO₂ of 31 mmHg, PaO₂ of 82 mmHg, and SpO₂ of 95%. Brain computed tomography at presentation to the ED demonstrated acute SAH in both the sylvian cisterns and cortical sulci. Although chest radiography and chest computed tomography revealed a right fifth rib fracture, pneumothorax was not observed in either lung upon presentation (Figure 1). The patient did not experience loss of consciousness due to the SAH, and she showed no symptoms or signs of increased intracranial pressure. Mild right leg weakness was also present. The patient was placed under observation; after showing improvement, she was scheduled for shoulder arthroscopic surgery to treat the left scapular body and glenoid fractures. After stabilization of her condition at 10 days after admission, the patient was taken to the operating room for arthroscopic-guided percutaneous screw fixation of the left scapular body and glenoid fractures.

In the operating room, the patient was connected to a monitoring system for measurement of noninvasive BP, ECG, pulse oximetry, esophageal temperature, and the bispectral index (BIS). Her vital signs were normal, with systolic BP of 128 mmHg, diastolic BP of 69 mmHg, heart rate of 90 beats/min, and SpO₂ of 99%. Anesthesia was induced using fentanyl 50 mcg (0.71 mcg/kg) and propofol 100 mg (1.42 mg/kg), and neuromuscular blockade was achieved with rocuronium 50 mg (0.71 mg/kg). After 3 minutes, endotracheal intubation was performed using a high-volume, low-pressure cuff with an inner diameter of 7 mm. The patient underwent neuromuscular monitoring at the right adductor pollicis muscle with ulnar nerve

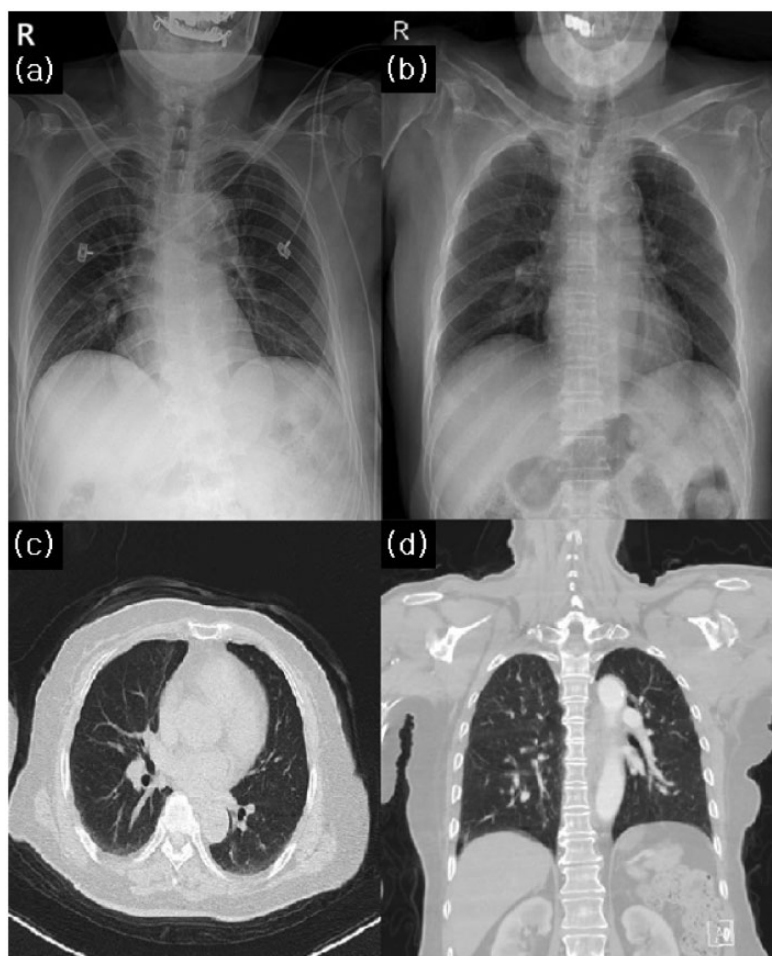


Figure 1. (a) Chest radiograph at the time of arrival to the emergency department. (b) Chest radiograph 1 day before surgery. (c) Axial view and (d) coronal view of chest computed tomography at the time of arrival to the emergency department.

stimulation using a neuromuscular transmission monitor (ToFscan; Dräger, Lübeck, Germany). An esophageal temperature probe was then inserted for temperature measurements. Anesthesia was maintained with oxygen and nitrous oxide (1:1), with a fresh gas flow of 3 L/min and desflurane at 5% to 8%. The patient was changed to the right lateral decubitus position with an axillary roll for surgery. During surgery, the patient was connected to a fluid management system that

intermittently pumped fluid into the joint cavity at a pressure of 50 cmH₂O and volume equal to the amount removed by suction, thus maintaining constant pressure. The patient's vital signs were maintained at the following levels: systolic BP, 80 to 140 mmHg; diastolic BP, 55 to 75 mmHg; mean BP, 58 to 86 mmHg; heart rate, 92 to 108 beats/min; SpO₂, 99% to 100%; and BIS, 40 to 60. Respiration was maintained through volume-controlled ventilation at a tidal

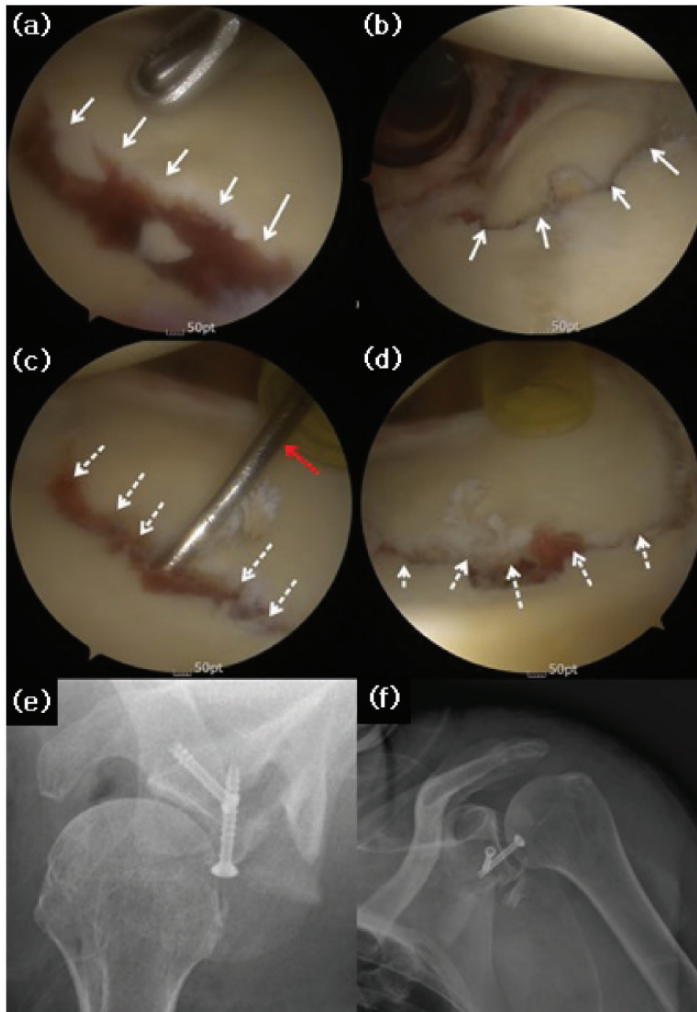


Figure 2. (a), (b) A glenoid fracture was found during arthroscopic examination of the glenohumeral joint. (c), (d) After reduction and cannulated screw fixation, reduction and maintenance of the glenoid fracture site was confirmed. Red arrow in (c): tip of the arthroscopic shaver. (e) Axillary lateral view and (f) shoulder anteroposterior view of simple radiographs at the time of routine postoperative examination of the fracture site. Solid arrows: glenoid articular fracture line before reduction. Dotted arrows: reduced articular fracture line.

volume of 7 mL/kg, respiratory rate of 10 breaths/min, airway pressure of 12 to 15 mmHg, end-tidal CO_2 of 30 to 33 mmHg, and inspiration:expiration ratio of 1:2. Positive end-expiratory pressure (PEEP) was not applied. During surgery, traction was applied on the operated arm (left arm) using an upper extremity limb

positioner (Spider Limb Positioner; Smith + Nephew, Watford, UK). The arthroscopic surgical views and radiological views are shown in Figure 2. The total duration of anesthesia was 2 hours 15 minutes, and the total operative time was 1 hour 30 minutes. Upon completion of the surgery, the patient was changed to the supine

position and a recruitment maneuver was performed (peak inspiratory pressure of 30–40 cmH₂O for 20–30 s) to prevent postoperative pulmonary complications. After confirming the recovery of spontaneous breathing through three repeated recordings of a TOF count of T3 and BIS of ≥ 60 , sugammadex 2 mg/kg was injected. After 5 minutes, the SpO₂ reached 100% and the tidal volume exceeded 320 mL. The patient was able to follow verbal cues to open her eyes and lift her head, and extubation was performed after confirming a TOF ratio of 0.95 and BIS of ≥ 80 . The patient was transferred to the PACU.

The patient maintained an SpO₂ of 100% in the PACU with stable vital signs and reported no unusual symptoms that may indicate pneumothorax. She was transferred to the ward approximately 30 minutes later, and chest radiography was performed to examine the surgical site.

The chest radiographic examination revealed left-sided pneumothorax (Figure 3). Therefore, a 23G chest tube was immediately inserted into the fourth intercostal space at the left mid-axillary line. Subsequent daily chest radiographic examinations showed improvement in the pneumothorax. The left chest tube was removed 3 days later. Even after removal of the tube, the patient's vital signs remained stable (BP, 100/64 mmHg; heart rate, 86 beats/minute; SpO₂, 98%), and she developed no relevant symptoms such as dyspnea or chest pain. The patient was transferred to the rehabilitation medicine department 8 days after removal of the chest tube and underwent rehabilitation therapy for right-sided leg weakness caused by SAH.

The reporting of this study conforms to the CARE guidelines.³ Written informed consent was obtained from the patient's family before publication of her anonymized data. All studies involving human participants were reviewed and approved by the Institutional Review Board of

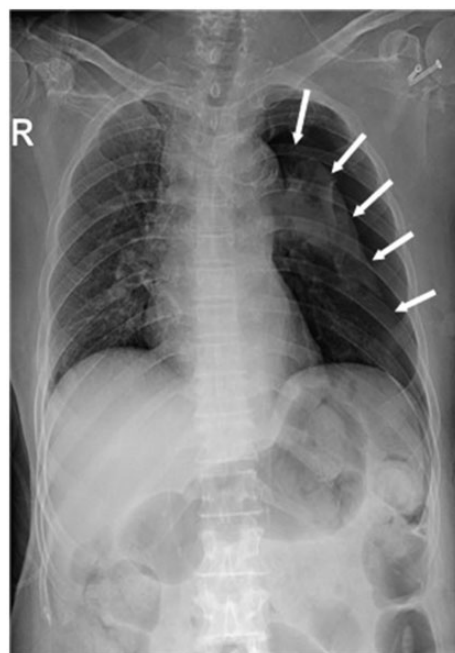


Figure 3. Chest radiograph at the time of the routine postoperative examination. Pneumothorax was present on the left side of the chest (arrows). The fixation screw was present in the left scapular region.

Daejeon Eulji University Medical Center (IRB approval no. 2022-02-002).

Discussion

The incidence of postoperative complications associated with shoulder arthroscopic procedures reportedly ranges from 5.8% to 9.5%.⁴ As a postoperative complication, primary spontaneous pneumothorax has an age-adjusted annual incidence of 7.4 to 18.0 cases per 100,000 population in men and 1.2 to 6.0 cases per 100,000 population in women.⁵ Primary spontaneous pneumothorax typically occurs in tall, thin patients; other risk factors are male sex and tobacco and/or cannabis smoking.^{5–7} Smoking increases the relative risk of developing a first episode of spontaneous pneumothorax by approximately 9-fold in women and 22-

fold in men.⁵ The patient described in the present report was a nonsmoker, suggesting that smoking was not a contributing factor in this case. Hence, the patient's pneumothorax is speculated to have been primarily caused by trauma. The use of nitrous oxide and recruitment maneuvers for respiratory management might have also contributed to the onset of pneumothorax. Shoulder arthroscopy performed under general anesthesia is another potential cause. In addition, the surgery was performed with the patient in the right lateral decubitus position. As mentioned above, the body position during surgery and anesthetics used for surgery may contribute to the development of pneumothorax depending on the patient's status.

The causes of pneumothorax can be broadly divided into patient-related, surgery-related, and anesthesia-related factors. Patient-related factors may include organic pulmonary changes, such as emphysema; however, there were no unusual findings in our patient's history, symptoms, or test results.⁸ Other patient-related factors associated with pneumothorax occurring as a postoperative complication, as in our case, may include a preoperative history of a pleural tear or bleb/bulla rupture secondary to lung disease or injury.⁶ Our patient had SAH, a right fifth rib fracture, and left scapular body and glenoid fractures, and although we scheduled the surgery after ensuring that the patient had remained stable for about 10 days post-injury, pneumothorax occurred postoperatively. Although no lesions were detected on the left side even after our patient had sustained massive trauma that led to the right fifth rib fracture, she might have had a vulnerable or blind lesion that caused a left pleural injury.

The arthroscopic-guided percutaneous screw fixation and body position used during surgery for the left scapular body and glenoid fractures might have been contributory factors to the pneumothorax in

the present case.⁹ Some potential surgery-related factors in our patient include the use of a gas-driven shaver or guide pin during shoulder arthroscopy, which may have damaged the upper tip of the pleura. Although pneumothorax caused by overpenetration of a guidewire or penetration of a Kirschner wire used for temporary fixation during arthroscopic-guided percutaneous screw fixation for correction of left scapular body and glenoid fractures is extremely rare, it may be a life-threatening complication once it occurs; thus, close monitoring of patients is important.¹⁰ We reviewed the video recordings of the arthroscopic procedure and observed no events that may have induced the pneumothorax. Furthermore, fluid irrigation was continuously performed during surgery, and fluid leakage outside the joint cavity caused by perforation secondary to overpenetration by a guidewire or screw would have caused fluid-related complications as well.¹⁰ However, our patient had no relevant symptoms or signs.

The body position used for shoulder arthroscopy may also be associated with pneumothorax. Lee et al.¹¹ reported a series of three cases of extensive subcutaneous emphysema, pneumomediastinum, and tension pneumothorax during or immediately after shoulder arthroscopy with subacromial decompression in patients placed in the semi-upright beach chair position. The authors hypothesized that these complications were the result of transient development of negative pressure in the subacromial space relative to atmospheric pressure due to the use of a power shaver with suction in the upright position.^{10,11} In our case, we reviewed the video recordings of the shoulder arthroscopic procedure performed in the lateral decubitus position but observed no events that could have induced the pneumothorax. Similar to the report by Lee et al.,¹¹ it is possible that excessive negative pressure temporarily applied to the pleural cavity due to arm traction during

the shoulder arthroscopy caused a pleural injury in our patient, which could be linked to the onset of pneumothorax.

Because regional anesthesia (e.g., brachial plexus block) was not performed in our patient, it can be ruled out as a contributory factor. Endotracheal intubation and insertion of an esophageal temperature probe were performed smoothly with no complications. Other factors, such as the use of nitrous oxide and intraoperative respiratory management, may have instead been the causes.^{12,13} Although our patient had multiple trauma, the use of nitrous oxide as an anesthetic was not an absolute contraindication. However, other anesthetics may be preferable because the use of nitrous oxide as well as barotrauma caused by an excessively high airway pressure or a large tidal volume may result in pneumothorax.¹² Nevertheless, this was unlikely in our case because we maintained a tidal volume of 7.0 mL/kg and airway pressure of 12 to 15 mmHg using volume-controlled ventilation without PEEP. Still, we cannot rule out the potential effect of the recruitment maneuver (inspiratory pressure of 30–40 cmH₂O for 20–30 s) performed during the recovery from anesthesia after changing the patient to the supine position. Our patient's chest trauma caused the left lung injury, left scapular body and glenoid fractures, and right fifth rib fracture. Although these injuries were not problematic preoperatively (because the patient was stable), they might have been exacerbated during surgery because of the lateral decubitus position and arm traction or the use of nitrous oxide as an anesthetic and application of the recruitment maneuver. This exacerbation may have contributed to the onset of pneumothorax. However, Patel et al.¹³ reported that controlling for key patient characteristics during their multivariate analysis did not change the results, and nitrous oxide anesthesia was not

associated with a greater risk of pneumothorax or atelectasis in their study.^{13,14}

Symptoms of pneumothorax can include chest pain, shortness of breath, coughing, and an increase in the heart rate or respiratory rate.⁹ In one study, about 21% of pediatric patients with spontaneous pneumothorax showed abnormal ECG findings,¹⁵ although such abnormalities may depend on the severity of the pneumothorax and side of the body affected (left vs. right). Minotti et al.¹⁶ found that the specificity is high but sensitivity is low for many ECG abnormalities. Thus, ECG signs are not suitable as a screening tool for pneumothorax. However, the presence of positive ECG signs as discussed above might raise suspicion for pneumothorax in patients presenting with dyspnea or vague chest discomfort; this may in turn lead to early imaging and, in the case of confirmation, early treatment of pneumothorax.¹⁶ Our patient had no suspicious respiratory symptoms, signs, or ECG changes for about 1 hour after surgery until chest radiography was performed. The pneumothorax seems to have developed slowly because the patient was older (in her early 70s) and maintained a PaO₂ of 82 mmHg and SpO₂ of 95% as determined by arterial blood gas analysis in the ED. Moreover, only one change in body position occurred during surgery, and the patient was continuously given 50% oxygen through a Venturi mask in the PACU, which helped maintain a stable SpO₂ of 98% to 100%. These factors might have hindered early detection.

Radiography can confirm the diagnosis of pneumothorax in most cases. Sometimes, very minor pneumothorax cannot be seen on a chest radiograph and is instead diagnosed with chest computed tomography or ultrasound.⁶ In our case, we were able to diagnose the pneumothorax based on routine postoperative chest radiography. For patients with chest trauma, as in our patient, clinicians should consider including

chest radiography as a routine examination to ensure early diagnosis.

Once life-threatening tension pneumothorax has developed, the pressure in the chest cavity must be immediately released, and needle thoracostomy can be performed on an emergency basis. Non-life-threatening pneumothorax is treated differently. If the pneumothorax is very minor and causes minimal or no discomfort, no major treatment is needed. A physician will typically monitor the patient in a hospital and obtain chest radiographs to ensure that the air volume within the pleural space is not increasing. For more severe pneumothorax, the air must be removed to allow the lung to re-expand by placing a chest tube.^{6,17}

Early recognition of pneumothorax and immediate termination of pump infusion and power shaver suction, along with other appropriate treatments, may be life-saving. Because of the life-threatening nature of the complications, we suggest reappraisal of the safety of shoulder arthroscopy.¹¹ In the present case, the onset of pneumothorax was not sudden and did not occur during surgery; therefore, immediate treatment was not required. However, because about half of the right chest area was affected by the pneumothorax, a chest tube was inserted into the left side immediately upon discovery. The tube was removed after 3 days because the patient showed no unusual symptoms and chest radiography confirmed that the pneumothorax had resolved.

In summary, we encountered a case of silent development of pneumothorax lacking relevant symptoms and signs following arthroscopic-guided percutaneous screw fixation in the right lateral position for left scapular body and glenoid fractures under general anesthesia in a woman with thoracic trauma but no history of lung disease. We were unable to determine the exact cause of the pneumothorax in this case; however, we recommend that clinicians consider the

possibility of pneumothorax as a complication following shoulder arthroscopic-guided fixation in patients with chest trauma. Respiratory management should ideally exclude nitrous oxide, and a low tidal volume without PEEP should be used. Patients should be followed up with routine postoperative radiography.

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Data availability statement

The data are available from the corresponding author on reasonable request.

Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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