

Pneumothorax in Arthroscopic Shoulder Surgery: A Multifactorial Risk Analysis and Case Report

Artroskopik Omuz Cerrahisinde Pnömotoraks: Çok Faktörlü Risk Analizi ve Olgu Sunumu

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ABSTRACT

Arthroscopic shoulder surgery is a procedure associated with significant pain, often requiring effective pain management to prevent prolonged hospitalization. Interscalene brachial plexus blocks, commonly used alongside general anesthesia, can mitigate the need for oral pain medications but carry risks. This case report examines pneumothorax, a potential complication during arthroscopic shoulder surgery, particularly when multiple contributing factors are present. Causes of pneumothorax include interscalene brachial plexus block, shoulder surgery, and pre-existing lung conditions. This report highlights the need for heightened awareness and careful risk management in such cases. Understanding these factors can inform clinical practices, optimize patient outcomes, and guide future research on risk mitigation strategies.

Keywords: Pneumothorax, plexus blocks, interstitial lung disease, risk management, prehabilitation

Öz

Artroskopik omuz cerrahisi ciddi ağrı ile ilişkili bir prosedürdür ve genellikle uzun süreli hastane yatışını önlemek için etkili ağrı yönetimi gerektirir. Genel anestezi ile birlikte yaygın olarak kullanılan interskalen brakiyal pleksus blokları, oral analjezik ihtiyacını azaltabilse de belirli riskler taşımaktadır. Bu olgu sunumunda, artroskopik omuz cerrahisi sırasında, özellikle birden fazla katkıda bulunan faktör mevcut olduğunda, potansiyel bir komplikasyon olan pnömotoraks incelenmektedir. Pnömotoraksın potansiyel nedenleri arasında interskalen brakiyal pleksus bloğu, omuz cerrahisi ve önceden var olan akciğer hastalıkları yer almaktadır. Bu rapor, söz konusu vakalarda farkındalığın artırılması ve dikkatli risk yönetiminin önemini vurgulamaktadır. Bu faktörlerin anlaşılması, klinik uygulamalara rehberlik edebilir, hasta sonuçlarını optimize edebilir ve risk azaltma stratejilerine yönelik gelecekteki araştırmalara yön verebilir.

Anahtar sözcükler: Pnömotoraks, pleksus blokları, interstisyel akciğer hastalığı, risk yönetimi, prehabilitasyon

INTRODUCTION

Pneumothorax, defined as air entering the space between the visceral and parietal pleura, can occur spontaneously or secondary to pre-existing conditions. Primary pneumothoraxes are common in tall, thin, young males, while secondary pneumothoraxes typically arise in patients with pre-existing lung disease. Iatrogenic pneumothorax results from physical damage, such as needle trauma or barometric injury (1). In the context of arthroscopic shoulder surgery, the interplay of patient-specific factors, surgical techniques, and anesthesia practices introduces unique challenges. This report details a pneumothorax during arthroscopic shoulder surgery requiring general anesthesia

and an interscalene brachial plexus block and examines the contributing factors and management strategies. Additionally, this case seeks to highlight the importance of multidisciplinary approaches to minimize complications and improve patient care.

CASE PRESENTATION

An 84-year-old female, weighing 67 kg, with a medical history including hypertension, chronic kidney disease, transient ischemic attack, type 2 diabetes on insulin, pulmonary sarcoidosis on steroids, gastroesophageal reflux disease, and chronic back pain managed with a spinal cord stimulator, presented for right reverse shoulder ar-

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throplasty due to chronic glenohumeral arthritis. During her preoperative assessment, her functional capacity was determined to be 1-3 metabolic equivalents of tasks. Pulmonary function tests were unavailable, and she was on daily prednisone for sarcoidosis. Her anesthesia history included postoperative nausea and vomiting.

On the day of her surgery, within the preoperative period, the patient received an interscalene single shot nerve block after anatomy was confirmed with ultrasound. The area was infiltrated with 3 mL of 1% lidocaine subcutaneously. Upon satisfactory location of the short beveled needle verified by ultrasound, 12 mLs of solution containing 0.5% ropivacaine and a total of 2.4 mg of dexamethasone was injected in 5 mL increments after aspiration did not show blood return. Throughout the entire procedure, the ultrasound was adjusted for continuous visualization of the needle. The patient tolerated the procedure well and vital signs were within normal limits.

Immediately after her block, the patient was transferred to the operating room. Upon arrival, the patient's oxygen saturation with a finger pulse oximeter was in the high 90 % prior to pre-oxygenation and she was hemodynamically stable. The pulse oximeter and blood pressure cuff were both placed on the left side given the location of the procedure was on the right. She was induced on the operating room table with 60 mg of lidocaine, 100 µg of fentanyl, 140 mg of propofol and 50 mg of rocuronium and intubated with direct laryngoscopy with a 7 mm cuffed tube without difficulty. Placement of the tube was confirmed with bilateral breath sounds, end tidal carbon dioxide, and equal chest expansion. The depth of the tube was 20 cm at the teeth and secured down with tape. The patient was placed on volume control auto flow mode with a volume set at 390 mL with peak inspiratory pressures ranging from 14 to 17 with sevoflurane as maintenance. Her gas flows were 2 L min⁻¹ oxygen and 2 L min⁻¹ of air. She was placed in a beach chair position for her operation. She only required one push of 4 µg of norepinephrine to maintain a mean arterial pressure greater than 65 mmHg. Fifty minutes after induction, the patient's oxygen saturation began to drop into the low 90 %. Her tidal volumes remained consistent with no change in peak inspiratory pressures required to maintain her tidal volumes. The lungs were auscultated at the apex bilaterally with clear equal and bilateral breath sounds. The circuit and endotracheal tube were checked and did not contain any obstruction or leaks within the system. The endotracheal tube depth was checked and unchanged. Initially, her digital pulse oximeter was changed to an ear pulse oximeter for better measurements without the blood pressure cuff changing the reading. The oxygen flow was also turned up to 4 L min⁻¹ and air was turned

down to 0.6 L min⁻¹. She required multiple pushes of 4 µg of norepinephrine to maintain her mean arterial pressures greater than 65 mmHg and her heart rate remained in the 60-80 beats per minute. Throughout the rest of the procedure she remained hemodynamically stable with the pushes of norepinephrine and 5 mg of ephedrine with her oxygen saturation remaining greater than 97% with consistent tidal volumes and peak inspiratory pressures.

Prior to extubation, the patient was properly reversed with 300 mg of sugammadex based on her train of four. She was taking in adequate tidal volumes spontaneously and was extubated. However, after extubation, she was unable to maintain oxygen saturation levels above 88% without high flows of oxygen greater than 6 L min⁻¹. She required a non-rebreather at 10 L min⁻¹ for transport to the post anesthesia care unit (PACU). Despite her oxygen level requirements, the patient denied any symptoms of shortness of breath or chest pain. After transfer to the PACU, a chest X-ray was performed which demonstrated a large right sided pneumothorax with near complete right lung collapse as seen in Figure 1.

The patient had a chest tube placed in the PACU as seen in Figure 2. She was transferred to the intensive care unit for acute hypoxic respiratory failure management for two days. The chest tube was placed to suction for a day then transferred to water seal and remained for a total of two days with imaging revealing near resolution of her right-sided pneumothorax. The patient remained stable in the hospital for another day pending inpatient rehab placement.

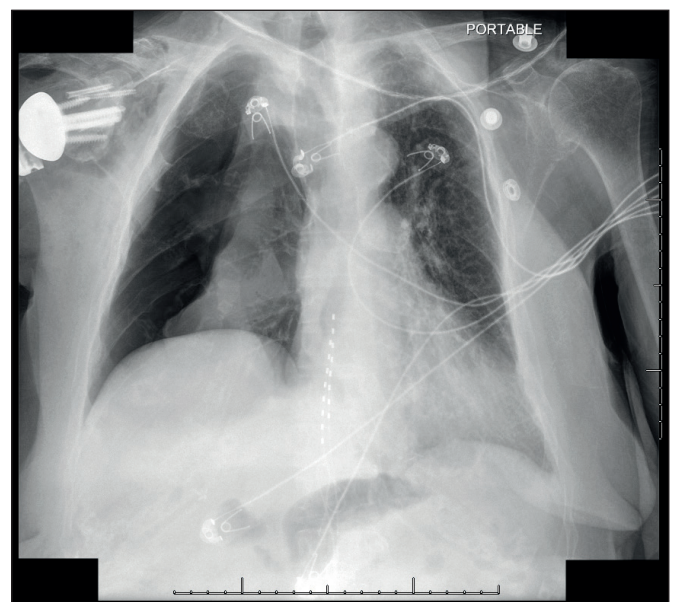


Figure 1. Post-operative chest X-ray with a large right-sided pneumothorax with near complete right lung collapse.

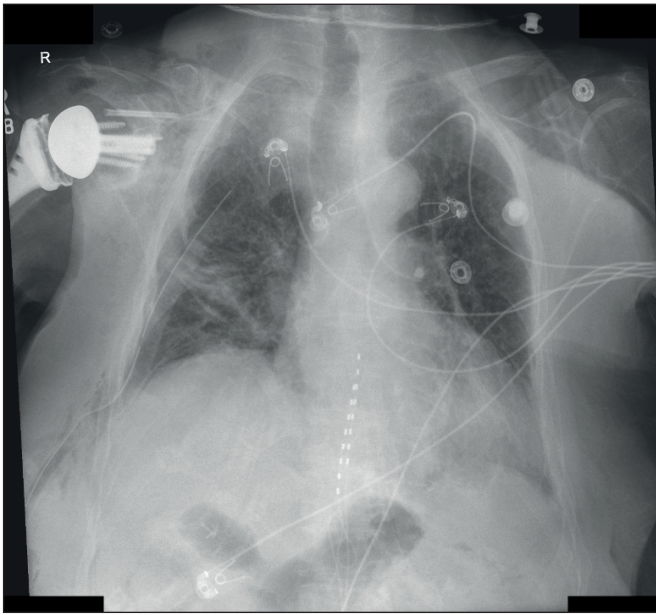


Figure 2. Chest X-ray after right chest tube placement with improvement of the right pneumothorax.

DISCUSSION

This case highlights the multifactorial nature of pneumothorax development during arthroscopic shoulder surgery. The interplay of anesthesia, surgical techniques, and patient-specific factors complicates the identification and mitigation of risks.

Interscalene Block

The interscalene brachial plexus block, widely used for postoperative pain management in shoulder surgeries, is effective in reducing opioid consumption and associated adverse effects (2). However, it carries risks such as phrenic nerve paresis, local infection, hematoma, and pneumothorax. While the risk of pneumothorax is rare, particularly with ultrasound-guided blocks, it has been reported. Factors influencing this risk include needle visualization, probe placement, operator experience, pre-existing lung disease, and patient body habitus (3). A recent literature review of studies from 2014 to 2024 reports an incidence of approximately 0.2% for pneumothorax with ultrasound-guided interscalene blocks, emphasizing the importance of technique and vigilance (4). Additionally, suboptimal ultrasound visualization due to operator factors or challenging patient anatomy can increase risks. Detailed training and adherence to best practices in block administration are essential to minimize complications (3).

Shoulder Surgery

Pneumothorax as a complication of shoulder surgery

without regional anesthesia has also been reported. Hypothesized mechanisms include pressure changes in the subacromial space from pump infusion systems and rupture of mediastinal pleura during intra-articular shaving (5). Additional risks include prolonged surgical duration, increased irrigation fluid usage, and patient-specific anatomical variations (5-9). Although case reports highlight these associations, further research is needed to establish definitive causative links and preventative measures. Surgeons should maintain a high index of suspicion for pulmonary complications, particularly in complex cases or when unexpected symptoms arise. Interdisciplinary collaboration and real-time monitoring during surgery can further enhance safety (10).

General Anesthesia and Pre-Existing Lung Disease

General anesthesia in patients with underlying pulmonary conditions can increase the risk of pneumothorax. Intubation-related airway trauma or barotrauma, coupled with the presence of pulmonary sarcoidosis, may predispose patients to complications. Sarcoidosis-related bullae formation and spontaneous pneumothorax, though rare and only documented in case reports, should be considered (11,12). This patient's pulmonary sarcoidosis and chronic steroid use may have contributed to lung fragility, increasing her susceptibility to pneumothorax. Additionally, undiagnosed pulmonary comorbidities or acute exacerbations during surgery can complicate management. Proactive management, including preoperative optimization and close intraoperative monitoring, is critical to addressing these risks.

Multidisciplinary Approach

The effective management of pneumothorax in this context requires a coordinated effort among anesthesiologists, surgeons, and critical care teams. Preoperative planning should include detailed risk assessments and contingency plans for managing complications. Advanced imaging techniques and intraoperative monitoring tools can aid in early detection and response to adverse events. Furthermore, postoperative care protocols should prioritize patient stabilization and facilitate recovery through targeted interventions. Leveraging electronic health records for real-time alerts and trends may enhance decision-making and outcomes.

CONCLUSION

This case underscores the importance of recognizing pneumothorax as a multifactorial complication during shoulder surgery. Comprehensive preoperative evaluations should focus on identifying risk factors, including pulmonary

conditions and procedural complexities. Detailed consideration of patient history, particularly in individuals with pre-existing pulmonary conditions, is essential to tailoring anesthesia and surgical strategies to mitigate risk. Intraoperative vigilance and prompt recognition of oxygenation issues are critical for timely intervention and minimizing complications. Although the direct cause of this patient's pneumothorax is unclear, future studies should aim to elucidate the specific mechanisms contributing to pneumothorax in various contexts and develop standardized protocols to prevent pneumothorax occurrence. By enhancing our understanding of the interplay between anesthesia, surgical techniques, and patient-specific factors, clinicians can refine approaches to patient care. Continued education and training in advanced monitoring and intervention techniques will also play a pivotal role in improving patient safety.

In conclusion, managing high-risk procedures such as arthroscopic shoulder surgery requires a multidisciplinary approach that integrates surgical expertise, anesthetic precision, and robust postoperative care. Through proactive risk management, early recognition of complications, and collaborative practices, the medical community can achieve better outcomes and ensure the highest standards of care for patients undergoing complex surgeries.

Consent

The patient provided verbal consent over the phone for publication of this case report.

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AI was used to help edit portions of this article but was not used to create content or to find information presented.

AUTHOR CONTRIBUTIONS

Conception or design of the work: SS

Data collection: AB

Data analysis and interpretation: AB

Drafting the article: AB

Critical revision of the article: SS

Other (study supervision, fundings, materials, etc): SS, AB

The author (SS, AB) reviewed the results and approved the final version of the manuscript.

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