Large asymptomatic pneumothorax following arthroscopic-assisted acromioclavicular joint reconstruction after ultrasound-guided interscalene block: a case report

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Interscalene brachial plexus blockade is commonly used for perioperative pain control for many arthroscopic and open shoulder procedures. It has been shown to improve postoperative pain control, decrease postoperative opioid administration, decrease overnight hospitalizations, increase operating room efficiency, and reduce recovery times.9 The more routine use of ultrasound guidance during interscalene blocks has increased the safety and efficiency of block placement; however, multiple potential complications still exist, including infection, bleeding/hematoma, neurovascular injury, diaphragmatic hemiparesis due to phrenic nerve palsy, Horner’s syndrome, and pneumothorax.1 Several case reports have detailed instances of pneumothorax after arthroscopic shoulder surgery, including cases with and without the use of interscalene nerve block.4-6,8 These cases resulted in intraoperative or immediate postoperative alterations in vital signs or symptomatology, allowing timely diagnosis and management. The present report describes a patient with a large, clinically asymptomatic pneumothorax after an arthroscopic-assisted shoulder procedure performed after ultrasound-guided interscalene nerve block, detected incidentally on a postoperative clavicle x-ray obtained to assess hardware position and acromioclavicular joint alignment. Potential etiologies for this clinically occult pneumothorax, and its implications for technical considerations during surgery as well as perioperative monitoring, are examined.

Case report

A 30-year-old right-hand-dominant woman presented to clinic 4 weeks after a motor vehicle collision in which she sustained a right distal clavicle fracture. She was initially seen at an outside hospital and referred after failure of nonoperative management with residual pain and deformity. At the time of presentation, the patient demonstrated significant displacement at the fracture site, notably increased from her injury films. After the discussion of operative and nonoperative treatment options, the patient was consented for right shoulder arthroscopic-assisted acromioclavicular joint reconstruction and possible open distal clavicle resection.

The patient underwent a routine ultrasound-guided interscalene nerve block by the anesthesia team preoperatively without notable complication (Fig. 1), before the administration of general anesthesia. She was placed in the beach chair position with the right arm in an arm holder (Smith and Nephew, Andover, MA, USA). Standard posterior and anterolateral portals were created through which a diagnostic arthroscopy was performed without evidence of intra-articular pathology. Arthroscopic dissection was undertaken to expose the base of the coracoid. An accessory anterior inferior portal was made to assist with drill guide positioning, which was confirmed with fluoroscopy. A small incision was made over the distal clavicle, approximately 3.5-4 cm medial to the fracture site. A guide pin was then inserted through the drill guide through 4 cortices to the base of the coracoid with terminal arthroscopic visualization, with the tip of the pin captured by the drill guide. The pin was then overdrilled with a 3.5-mm drill bit, and
a knotless cortical suspensory button (Arthrex, Naples, FL, USA) was then advanced through the 4 cortices and flipped on the undersurface of the coracoid. The button was then toggled down to the level of the superior clavicle and secured in a knotless fashion, providing the satisfactory reduction of the coracoclavicular distance. An attempt was made to achieve the satisfactory reduction of the distal clavicle fracture fragment; however, there remained significant mobility at the fracture site and the satisfactory reduction could not be maintained. Because of the risk of nonunion and persistent pain and mobility at the fracture site, the decision was made to proceed with an open distal clavicle resection, which was performed in a standard fashion.

The patient remained stable throughout the procedure and was extubated and transported to the post anesthesia care unit (PACU). Limited fluoroscopic images were obtained intraoperatively, and formal clavicle x-rays were obtained in the PACU to assess hardware position and acromioclavicular joint alignment (Fig. 2). These x-rays demonstrated an incidental finding of a large tension pneumothorax on the operative right side with mediastinal shift. The patient denied any chest pain, shortness of breath, or other symptoms. The measured oxygen saturation never fell below 95% on room air. A pigtail catheter was emergently placed by the general surgery team with near complete resolution of the pneumothorax (Fig. 3), and the patient was admitted for further observation. The pigtail catheter was removed on postoperative day 1. The patient remained asymptomatic throughout her hospital course. She was discharged on postoperative day 4 after near complete resolution of her remaining apical pneumothorax. She was seen 2 weeks later for her first postoperative visit and denied any chest pain or shortness of breath.

Discussion

This case illustrates the potential risks associated with shoulder arthroscopy using interscalene nerve blockade despite recent advances in the technique, namely the routine use of ultrasound guidance. The reported complications include vocal hoarseness, Horner’s syndrome, and hemidiaphragmatic paresis caused by temporary blockade of the ipsilateral recurrent laryngeal nerve, stellate ganglion, and phrenic nerve, respectively. Other documented complications include infection, bleeding/hematoma, and multiple potential pulmonary complications, including subcutaneous emphysema, pneumomediastinum, and tension pneumothorax. Cases of pneumothorax have also been reported in patients who underwent shoulder arthroscopy under general anesthesia without interscalene nerve blockade. However, most of these patients had histories significant for smoking or pre-existing lung disease, and the pneumothorax was attributed to ruptures of blebs or bullae due to pressure gradients created by the positive pressure from ventilation or the arthroscopic pump and shaver system. Furthermore, previously reported cases of pneumothorax after shoulder arthroscopy presented with either intraoperative changes in vital signs or symptoms and clinical examination findings in the immediate postoperative period. To our knowledge, this is the first reported case of a large, clinically asymptomatic tension pneumothorax in an otherwise healthy nonsmoker after shoulder arthroscopy performed using interscalene nerve blockade and detected incidentally on postoperative imaging other than a chest radiograph, in this case a clavicle x-ray obtained to assess hardware position and acromioclavicular joint alignment.

The routine use of ultrasound guidance has significantly reduced the rate of neurologic, cardiac, and pulmonary complications associated with interscalene nerve blockade, including the rate of pneumothorax, previously reported as high as 3%. Smokers and patients with pre-existing lung disease appear to be at higher risk for pneumothorax during interscalene block placement despite the use of ultrasound guidance. Mandim et al reported a case of pneumothorax in a smoker after an ultrasound-guided interscalene block performed before open reduction internal fixation of a right ulna fracture. Despite being stable throughout surgery, the patient complained of chest pain associated with dyspnea and decreased pulse oximetry in the PACU. Although pulmonary auscultation was normal, a chest x-ray revealed the presence of an ipsilateral right pneumothorax. The authors attributed the accidental pleural puncture to an unusually higher pleural dome due to a hyperinflated lung caused by chronic smoking.
There are multiple reports of perioperative pulmonary complications with shoulder arthroscopy performed under general anesthesia without interscalene nerve blockade. Dietzel and Ciullo reported 4 cases of pneumothorax after shoulder arthroscopy performed under general anesthesia in the lateral decubitus position. All patients had a history significant for smoking or asthma. The authors attributed these cases of pneumothorax to spontaneous rupture of underlying blebs or bullae from pre-existing lung disease, which are difficult to detect and typically located in the upper lung. They posited that the pressure gradient from the positive pressure of anesthesia and the ipsilateral lung is highest in the lateral decubitus position, increasing the chance of rupture. Oldman and Peng reported a case of spontaneous pneumothorax after arthroscopic labral repair and decompression in a 41-year-old American Society of Anesthesiologists grade 1 nonsmoker. The preoperative nerve block was cancelled, and the case proceeded under general anesthesia alone. The patient developed chest pain and hypoxia 50 minutes postoperatively, and a chest radiograph revealed a small pneumothorax, which was managed conservatively without drainage. Although the incidence of pneumothorax after interscalene nerve block (0.2%-3%) is substantially higher than that of spontaneous pneumothorax (16.8/100,000), the authors cautioned against the reflexive implication of the nerve block in such cases, which might have occurred in their case had the preoperative nerve block proceeded as planned. Such false assumptions may have important medicolegal implications. Given the highly operator-dependent nature of complications of interscalene nerve block, the risk of pneumothorax after this procedure may be increased at academic teaching institutions such as our own, where residents and nurse anesthetists are often performing the procedure under the guidance of the anesthesiologist.

Lee et al. reported 3 cases of subcutaneous emphysema, pneumomediastinum, and bilateral tension pneumothorax after arthroscopic subacromial decompression performed in the beach chair position under general anesthesia without the use of a nerve block. None of the patients had pre-existing lung disease. The authors proposed a mechanism implicating the arthroscopic pump and shaver system. Intermittent pump infusion is typically used to maintain a relatively constant pressure (approximately 50 mm Hg) in the subacromial space. When the power shaver is turned on with high intermittent suction, the pump infusion may run continuously to keep up with the suction and maintain a constant pressure. This may cause the pressure in the subacromial space to drop transiently and become negative relative to the atmospheric pressure. The authors posited that this transient drop in pressure may cause air to enter the arthroscopic portals. When the power shaver with suction is turned off, the positive pressure from the pump infusion may push air into the surrounding soft tissues, causing extensive subcutaneous emphysema. The air may penetrate into the axillary sheath and prevertebral space of the neck, resulting in pneumomediastinum. A further increase in mediastinal pressure due to positive pressure ventilation may result in rupture of the parietal pleura, leading to pneumothorax.

Calvisi et al. reported a similar case of subcutaneous emphysema and pneumomediastinum after shoulder arthroscopy with brachial plexus block in a nonsmoker with no cardiopulmonary comorbidities. They examined potential etiologies including possible early puncture of the prevertebral fascia during scalenic block, as well as a later Bernoulli effect created by the pump, high suction shaver, and outflow cannula, similar to the mechanism proposed by Lee et al. Their patient developed a coughing episode 15 minutes after inception of surgery, which may have suggested an impending airway problem, and subsequently developed chest pain exacerbated by breathing the morning after surgery. Chest x-ray and computed tomography scan revealed pneumomediastinum after arthroscopic subacromial decompression performed in the beach chair position under general anesthesia without the use of a nerve block.
and subcutaneous emphysema in the left thoracic and neck region, which resolved after 72 hours.

Although similar mechanisms postulated by Lee et al.5 and Calvisi et al.2 may be contributory, the clinical case presented herein differs from these and previously published cases in several key aspects. All 3 cases reported by Lee et al.5 demonstrated immediate and extensive postoperative swelling and subcutaneous air in the face, chest, and/or neck, as well as chest tightness in 1 case. These postoperative findings prompted immediate chest x-ray evaluation and prompt diagnosis of subcutaneous emphysema, pneumomediastinum, and/or pneumothorax in all 3 cases. The patient reported by Calvisi et al.2 had an intraoperative coughing episode that the authors acknowledged may have been underestimated, and went on to develop chest pain and subcutaneous emphysema the morning after surgery. Our case is unique in that the patient demonstrated no intraoperative or early postoperative signs of respiratory compromise, despite the incidental finding of tension pneumothorax on routine postoperative imaging of the clavicle. Furthermore, our case involved only limited arthroscopic evaluation of the glenohumeral joint and exposure of the base of the coracoid for hardware placement. There was no formal entrance into or evaluation of the subacromial space, and limited use of the arthroscopic shaver. The procedure was then completed in a limited open fashion, resulting in minimal postoperative soft tissue swelling. If pneumothorax represents the end stage of a progression from subcutaneous emphysema and pneumomediastinum as proposed by Lee et al.5 this mechanism may be less likely to have been the etiology of the pneumothorax in our case. Therefore, other potential etiologies such as accidental pleural puncture during interscalene nerve block or spontaneous pneumothorax must be considered, both of which are exceedingly rare in a healthy nonsmoker.

**Conclusion**

Both the surgical and anesthesia teams should be cognizant of the risk of pulmonary complications associated with shoulder arthroscopy performed both with and without interscalene nerve blockade. All intraoperative and postoperative shoulder imaging should be critically analyzed to assess visualized lung fields, and any atypical respiratory signs or symptoms should be promptly investigated. The potentially occult presentation of life-threatening complications such as a tension pneumothorax necessitates a high index of suspicion and a low threshold for further workup, especially in high-risk patients.

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**References**

1. Bruce BG, Green A, Blaine TA, Wesner LV. Brachial plexus blocks for upper extremity orthopaedic surgery. J Am Acad Orthop Surg 2012;20:38–47. https://doi.org/10.5435/JAAOS-20-01-038.
2. Calvisi V, Luparelli S, Rossetti S. Subcutaneous emphysema and pneumomediastinum following shoulder arthroscopy with brachial plexus block: a case report and review of the literature. Arch Orthop Trauma Surg 2009;129:349–52. https://doi.org/10.1007/s00402-008-0593-y.
3. Dietzel DF, Ciullo JV. Spontaneous pneumothorax after shoulder arthroscopy: a report of four cases. Arthroscopy 1996;12:99–102.
4. Kim JB, Choi MK, Jeon YK, Lee JM. Chest wall swelling and pneumothorax after shoulder arthroscopy: Were the 2 events totally independent? Medicine 2017;96:e7020. https://doi.org/10.1097/MD.0000000000007020.
5. Lee H-C, Dewan N, Crosby L. Subcutaneous emphysema, pneumomediastinum, and potentially life-threatening tension pneumothorax: pulmonary complications from arthroscopic shoulder decompression. Chest 1992;101:1265–7.
6. Li R, Lali A, Lai E, Gruson KL. Tension pneumothorax after ultrasound-guided interscalene block and shoulder arthroscopy. Am J Orthop (Belle Mead NJ) 2015;44:E407–10.
7. Mandim BL, Alves RR, Almeida R, Pontes JP, Arantes LJ, Morais FP. Pneumothorax post brachial plexus block guided by ultrasound: a case report. Rev Bras Anestesiol 2012;62:741–7. https://doi.org/10.1016/j.rbja.2012.08.003.
8. Oldman M, Peng P. Pneumothorax after shoulder arthroscopy: Don’t blame it on regional anesthesia. Reg Anesth Pain Med 2004;29:382–3. https://doi.org/10.1016/j.rapm.2004.04.002.
9. Wu CL, Rouse LM, Chen JM, Miller RJ. Comparison of postoperative pain in patients receiving interscalene block or general anesthesia for shoulder surgery. Orthopedics 2002;25:45–8.