CASE REPORT

Safe and Effective Perioperative Management in Patients with Atrial Septal Defect and Pulmonary Contusion: A Case Study with Supraclavicular Block

RTH Supraptomo, Andy Nugroho, Muhammad Baihaqi Siddik✉

Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Sebelas Maret/Dr. Moewardi General Hospital, Surakarta, Indonesia

✉Correspondence: Muhammad.baihaqi27@gmail.com

ABSTRACT

Background: Peripheral nerve blocks offer a safer anesthetic alternative in patients with congenital heart disease (CHD) by reducing cardiovascular and pulmonary risks associated with general anesthesia. The supraclavicular brachial plexus block provides effective anesthesia for upper limb surgery with improved hemodynamic stability, reduced complications, and better postoperative analgesia. This case report aims to demonstrate the safety and effectiveness of supraclavicular brachial plexus block as a perioperative anesthetic strategy in a high-risk patient with CHD and pulmonary contusion.

Case: A 67-year-old woman with a large secundum atrial septal defect (ASD), severe pulmonary hypertension, right ventricular dysfunction, and bilateral lung contusions on day 10 was scheduled for open reduction internal fixation (ORIF) of a distal radius fracture. Due to high cardiopulmonary risk, regional anesthesia was chosen. An ultrasound- and nerve stimulator-guided supraclavicular block using 20 mL of levobupivacaine 0.375% was performed. The procedure was completed successfully with stable hemodynamics and preserved spontaneous ventilation. Postoperatively, the patient was monitored in a high-care unit (HCU).

Discussion: Maintaining hemodynamic stability and avoiding increases in pulmonary vascular resistance (PVR) are critical in acyanotic left-to-right shunt CHD. General anesthesia and mechanical ventilation may disrupt Qp:Qs balance and worsen pulmonary function, especially in pulmonary contusion. Regional anesthesia minimizes these risks while providing adequate surgical conditions.

Conclusion: Supraclavicular brachial plexus block is a safe and effective alternative for upper limb surgery in high-risk CHD patients with acyanotic shunt lesions and pulmonary complications.

Keywords: adult congenital heart disease; pulmonary contusion; radius fracture; perioperative; supraclavicular block

INTRODUCTION

Regional anesthesia, including neuraxial, truncal, and peripheral blocks, has been effectively used in patients with pulmonary disorders and congenital heart disease (CHD).[1] Peripheral nerve blocks provide anesthetic effects while limiting systemic impact and avoiding the respiratory and cardiovascular depression commonly seen with general anesthesia. Their use extends to postoperative pain control, which can promote early mobilization and aid in the recovery of function and normal range of motion. In patients undergoing open reduction internal fixation (ORIF) surgery, peripheral nerve blocks are associated with shorter hospital stays. In addition, studies demonstrate that this technique is linked to minimal postoperative complications, including reduced incidence of postoperative delirium and postoperative nausea and vomiting (PONV), particularly in elderly patients with pre-existing comorbidities.[2]

The supraclavicular block, often referred to as the spinal of the arm due to its relatively rapid onset and reliability, provides deep and comprehensive anesthesia of the brachial plexus for surgical procedures in areas around or distal to the shoulder. Historically, the supraclavicular block was less favored due to the increased incidence of pneumothorax associated with paresthesia and nerve stimulator techniques. However, in recent years, this technique has regained popularity with the advent of ultrasound guidance, which significantly reduces the risk of pneumothorax. This regional anesthesia technique has minimal impact on cardiac and pulmonary function, thereby helping to lower the risk of hypotension, arrhythmias, and respiratory complications.[3]

This case report describes a specific scenario involving a 67-year-old female patient with pulmonary contusion, CHD (a large secundum atrial septal defect), and a high likelihood of pulmonary hypertension, who required surgical intervention for a radius fracture. The report emphasizes anesthetic strategies, key management considerations, and patient outcomes. This case highlights that anesthesia with peripheral nerve block represents a safe and effective option for high-risk patients with multiple comorbidities, while also providing important insights into optimizing anesthetic management in complex clinical situations.

CASE

A 67-year-old elderly female patient was scheduled for ORIF of the left distal radius due to a closed distal radius fracture. Four days before admission, the patient slipped while walking in the bathroom and fell, with her left hand bearing the weight of her body. Following the incident, she complained of chest pain, dyspnea, and pain in the left wrist, which worsened with movement. From an anesthetic standpoint, several important considerations were identified. Written informed consent was obtained for the procedure and publication of anonymized data.

As a geriatric patient with a normal body mass index (21.3 kg/m^2) and no signs of malnutrition (no sunken cheeks despite being edentulous), airway evaluation was favorable: mouth opening of three finger-breadths, Mallampati class II, no dentures or loose teeth, good neck mobility, and a normal thyromental distance. Therefore, no predictors of difficult airway were found. Preoperative hemodynamics were as follows: blood pressure 108/57 mmHg,

heart rate 54 bpm with atrial fibrillation and slow ventricular response noted on monitoring, respiratory rate 22/min, and SpO_2 97% on 3 L/min nasal cannula. The preoperative pain score assessed using the visual analog scale (VAS) was 4-5.

The patient's cardiopulmonary status was highly complex. On lung examination, chest expansion was symmetrical, but rhonchi and a systolic murmur (+) were present. Thoracic imaging revealed bilateral pulmonary contusions, pleural effusion versus bilateral hemothorax, and a complete fracture of the left posterior 8th rib (Figure 1). The patient had been co-managed by the thoracic surgery team and was receiving conservative therapy for pulmonary contusion.

She had a large secundum atrial septal defect (ASD) with bidirectional shunt (predominantly left-to-right), atrial fibrillation with non-variable response (AF NVR), and severe pulmonary hypertension with right ventricular dysfunction. Electrocardiogram (ECG, Figure 2) demonstrated AF with complete left bundle branch block (CLBBB), while echocardiography (Figures 3 and Figure 4) showed preserved left ventricular systolic function (EF 73%), concentric remodeling, and grade I diastolic dysfunction. The patient was under close monitoring by the intensivist and cardiology teams, receiving full medical therapy including sildenafil 20 mg three times daily, candesartan 8 mg once daily, spironolactone 25 mg once daily, furosemide 40 mg once daily, bisoprolol 5 mg once daily, and atorvastatin 20 mg once daily. Warfarin had been discontinued in preparation for surgery. The overall perioperative risk was assessed as moderate to high.

From an anesthetic perspective, the patient was classified as ASA III due to multiple comorbidities, including bilateral pulmonary contusion, AF NVR, large ASD with bidirectional shunt, severe pulmonary hypertension, and evidence of right ventricular dysfunction.

To minimize hemodynamic fluctuations and prevent increases in pulmonary vascular resistance (PVR) or decreases in systemic vascular resistance (SVR), a regional anesthetic approach was preferred. An ultrasound-guided supraclavicular brachial plexus block (Figure 5) with nerve stimulator assistance was performed using 20 mL of 0.375% levobupivacaine, combined with paracetamol as part of a multimodal analgesia regimen (Figures 6 and Figure 7). The patient was positioned semi-sitting with the head turned contralaterally. A high-frequency linear probe was placed above and parallel to the clavicle to identify the subclavian artery, first rib, pleura, and brachial plexus. The needle was inserted in-plane from posterior to anterior, and local anesthetic was injected in divided doses after negative aspiration, with Doppler used to avoid vascular puncture. Nerve stimulator guidance (0.8 mA, 100 μs) was used to confirm placement via finger twitch before injection.

Hemodynamics remained stable throughout the surgery, with intraoperative vital signs as follows: blood pressure 110/60 mmHg, heart rate 50 bpm with an irregular rhythm consistent with atrial fibrillation, respiratory rate 20 bpm, and SpO_2 97% on 3 L/min via nasal cannula. The intraoperative VAS score was 0, indicating adequate analgesia.

The patient was observed postoperatively in the high-care unit (HCU) under intensivist supervision and was transferred to a regular ward on postoperative day 3. This anesthetic plan reflects a tailored strategy to reduce perioperative risk in an elderly patient with CHD and severe pulmonary compromise.

Figure 1. Preoperative chest X-ray (PA view) showing bilateral pulmonary contusion and hemothorax

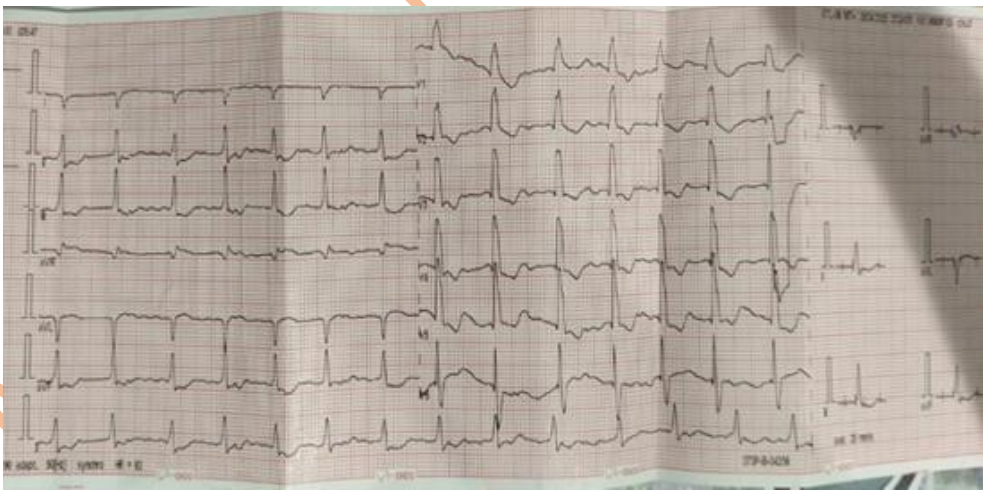

Figure 2. Electrocardiogram showing atrial fibrillation with AV-NVR and complete left bundle branch block (CLBBB)

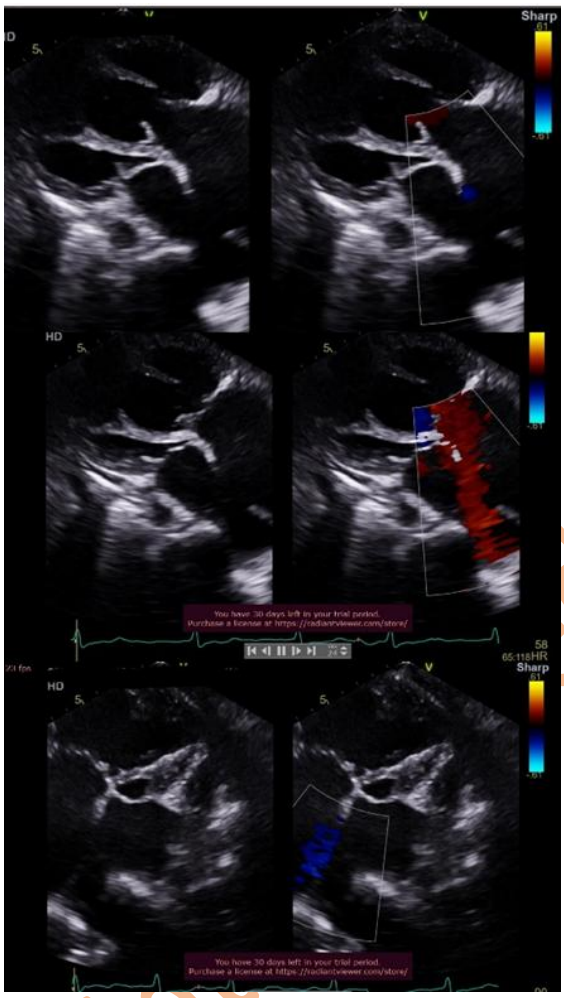

Figure 3. Echocardiogram showing ASD with bidirectional shunt

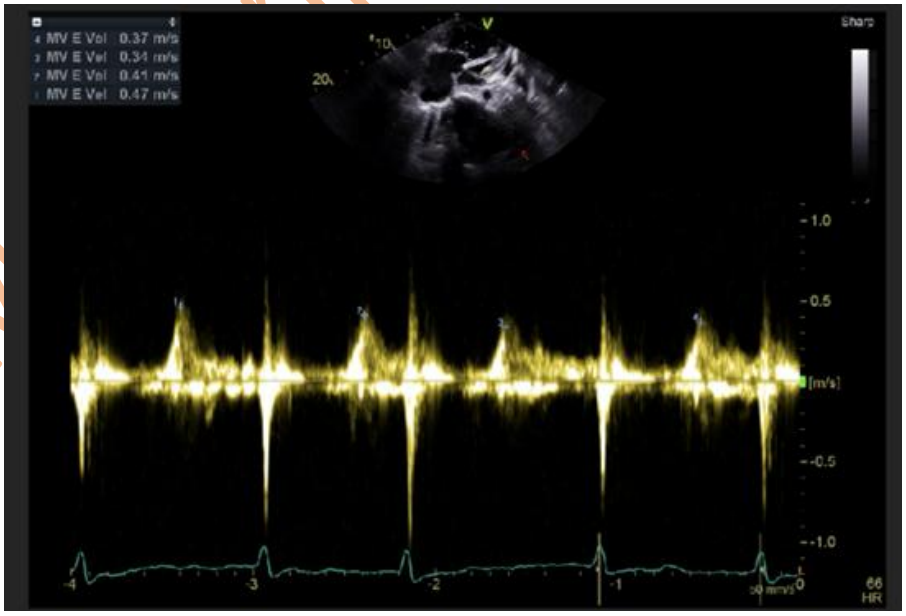

Figure 4. Echocardiogram demonstrating relatively low E-wave velocity (all < 0.5 m/s), indicating impaired early diastolic filling, consistent with diastolic dysfunction, likely grade I (impaired relaxation)

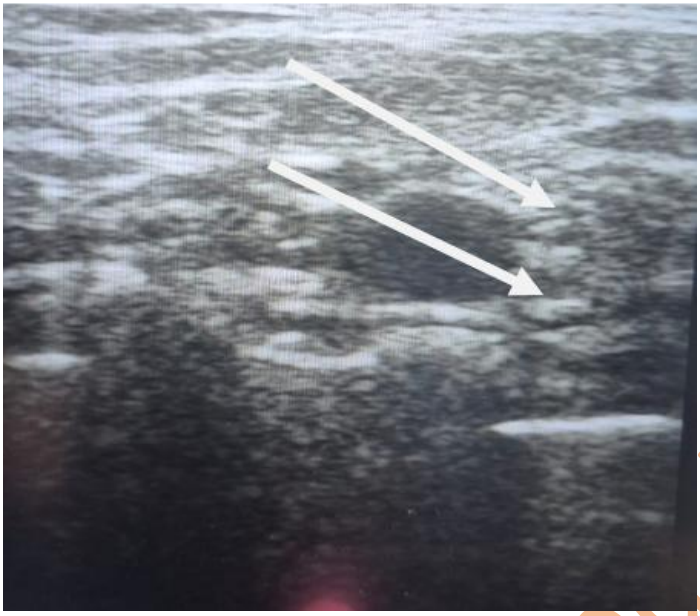

Figure 5. Supraclavicular nerve block procedure performed under ultrasound and nerve stimulator guidance

Figure 6. Emergency equipment and lipid emulsion

Figure 7. General anesthetic drugs and STATICS

DISCUSSION

This case involves a 67-year-old woman with a distal radius fracture and significant cardiopulmonary comorbidities, including ASD, atrial fibrillation, severe pulmonary hypertension, and pulmonary contusions. A supraclavicular brachial plexus block using 0.375% levobupivacaine (20 mL) was performed under ultrasound and nerve stimulator guidance. The procedure resulted in stable hemodynamics, preserved spontaneous ventilation, and effective analgesia (VAS 0), with an uncomplicated postoperative course.

Acyanotic shunt lesions are principally characterized by blood flow from the left to the right side of the heart or through the proximal great vessels. This shunting increases pulmonary blood flow, which ultimately raises PVR and subsequently triggers intimal hyperplasia and vascular remodeling. These processes culminate in pulmonary hypertension, right ventricular hypertrophy, and eventually congestive heart failure (CHF).[4]

Although less common in children compared to other acyanotic shunt lesions, ASD represents the majority of congenital heart defects detected in adults. In fact, ventricular septal defect (VSD) occurs more frequently than ASD but has a high rate of spontaneous closure (nearly 70%). Furthermore, small ASDs may remain asymptomatic for decades, which explains why this defect is more often diagnosed in adulthood.[5]

In individuals with cardiovascular disease, regional anesthesia—whether used alone or in combination with general anesthesia offers several perioperative advantages, including attenuation of the stress response, cardiac sympathectomy, faster extubation, shorter hospital stays, and improved postoperative pain control. Nevertheless, its use must be carefully considered in specific circumstances due to potential risks.[6]

Anesthetic management in patients with CHD, particularly those with shunt lesions, requires close attention to hemodynamic balance. In patients with left-to-right shunts (e.g., ASD or VSD), the goals of anesthesia and intraoperative management are to avoid worsening of left-to-right shunting and to prevent right-to-left shunting. This can be achieved by maintaining or appropriately adjusting the ratio between PVR and SVR, thereby minimizing the risk of deterioration and heart failure.[9]

Pulmonary contusion disrupts the alveolar-capillary barrier, leading to alveolar hemorrhage, fluid leakage, surfactant loss, and alveolar collapse. These changes result in reduced lung compliance, ventilation–perfusion (V/Q) mismatch, hypoxemia, and an increased risk of acute respiratory distress syndrome (ARDS). Such pathological alterations present significant challenges during anesthesia.[7]

In patients with pulmonary contusion, general anesthesia and mechanical ventilation may exacerbate lung injury if not managed carefully. Administration of large tidal volumes (VT > 10 mL/kg predicted body weight [PBW]) can induce ventilator-induced lung injury (VILI), worsen systemic inflammation, and negatively impact clinical outcomes, including intensive care unit (ICU) admission, prolonged hospital stay, and need for postoperative mechanical ventilation.[7,8]

These effects are particularly harmful in contused lungs, where already compromised alveoli are highly

susceptible to barotrauma and volutrauma from excessive pressure and tidal volume. Studies further emphasize that inaccurate PBW estimation can result in excessive tidal volumes, especially in female patients, those of short stature, and individuals with obesity who are already at higher risk for respiratory complications.[7,8]

Additionally, inflammation from pulmonary contusion is driven by immune activation and cytokine release, further sensitizing the lungs to injury, increasing the likelihood of ARDS. Anesthetic practices that fail to account for these risks, such as conventional tidal volume use without lung-protective strategies, may significantly worsen pulmonary function.[7,8]

Therefore, in patients with pulmonary contusion, anesthetic management should emphasize lung-protective strategies to prevent further pulmonary injury. This includes careful control of tidal volume, accurate estimation of PBW, and consideration of alternative anesthetic techniques to minimize ventilatory stress.[7,8,9]

The supraclavicular block is often described as the spinal of the arm due to its rapid onset and consistent results. [10,11] It provides dense anesthesia of the brachial plexus, making it particularly suitable for surgical procedures distal to the shoulder. With the increasing use of ultrasound guidance, the procedure has become more common, as this technique significantly reduces the risk of pneumothorax[12]. While many clinicians still view the supraclavicular block as technically challenging with a notable pneumothorax risk, its advantages, including rapid onset, dense and consistent anesthesia, and high success rate, make it a highly suitable method. As highlighted above, this technique remains "unrivaled" by other approaches. In clinical practice, the supraclavicular approach has become the primary regional anesthesia technique for distal upper extremity surgery, with routinely low complication rates.[13,14,15]

Based on the considerations outlined above, in this case, we elected to perform regional anesthesia in the form of a supraclavicular peripheral nerve block to mitigate the risks and complications posed by the patient's cardiovascular and pulmonary conditions. General anesthesia with endotracheal intubation, by contrast, carries a high risk of decreasing SVR, which would disrupt the Qs: Qp balance and could further compromise the patient's condition. In addition, the procedure was performed under an intraoperative tourniquet with anesthetic goals appropriately aligned with the indications for supraclavicular block (upper extremity surgery).

Regional anesthesia should be prioritized over general anesthesia for upper extremity procedures in patients with acyanotic shunt CHD and coexisting pulmonary pathology whenever feasible. Ultrasound-guided supraclavicular brachial plexus block combined with appropriate monitoring and adjunct techniques such as nerve stimulation provides a safe and effective approach to maintain hemodynamic stability, preserve spontaneous ventilation, and reduce perioperative cardiopulmonary complications.

CONCLUSION

In high-risk patients with CHD and pulmonary contusion undergoing upper extremity surgery, the supraclavicular brachial plexus block represents a safe and effective anesthetic option.

This technique provides efficient anesthesia while minimizing cardiovascular and respiratory risks by avoiding airway manipulation, reducing hemodynamic fluctuations, and decreasing pulmonary stress.

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