

# Ventricular tachycardia during arthroscopic shoulder surgery: a report of two cases

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**Abstract** We routinely have performed arthroscopic shoulder surgery under general anesthesia in the beach chair position using epinephrine (0.33 mg/L) saline irrigation. At a 2-week interval, two patients, a 19-year-old man scheduled to undergo an arthroscopic Bankart repair for left traumatic anterior instability and a 49-year-old woman scheduled for an arthroscopic rotator cuff repair for a left rotator cuff tear, were resuscitated by chest compression and defibrillation due to a sudden developed cardiogenic shock following ventricular tachycardia at the time of arthroscopic shoulder surgery. They were transferred to the intensive care unit because their emergent echocardiogram showed significantly decreased cardiac functions. They were fully recovered and then discharged. Epinephrine was considered to be the cause of ventricular tachycardia because the two patients showed no anaphylactic reaction to drugs or symptoms of air embolism related to the beach chair position. In addition, according to our observation of epinephrine flow patterns, it was more likely that highly concentrated epinephrine was rapidly infused into the body. This complication is very rare. However, thorough understanding of the side effects and

their development of epinephrine during arthroscopic shoulder surgery should neither be overemphasized nor disregarded.

**Keywords** Shoulder Arthroscopy · Complications · Ventricular tachycardia

## Introduction

A few cases of air embolism [1, 2], which may have been caused by the beach chair position during arthroscopic shoulder surgery, have been reported, but according to our knowledge, there is only one report of epinephrine-induced ventricular arrhythmia [3]. Although Jensen et al. [4] demonstrated that adding epinephrine to the irrigation fluid during diagnostic and therapeutic shoulder arthroscopy had potential advantages by reducing intra-articular bleeding, thereby improving the visual clarity without any adverse reactions, we cannot ignore potentially fatal side effects of epinephrine as a potent vasoconstrictor. Following two cases, which is the only experience out of total 2,000 arthroscopic shoulder surgery will show the examples of fatal cardiovascular collapse following ventricular tachycardia during shoulder arthroscopy within a short time interval of two patients' surgery.

## Case report

### Patient 1

A 19-year-old man (weight: 78 kg, body mass index: 24.9) who had complained of pain and instability of the left shoulder was scheduled for arthroscopic shoulder

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stabilization with the diagnosis of recurrent anterior instability. There were no abnormal findings in preoperative evaluations including electrocardiogram (EKG), blood chemistry, urinalysis, and chest roentgenogram. He had no history of cardiac or pulmonary abnormalities and no history of adverse reactions to general anesthesia.

On the day of surgery, glycopyrrolate 0.2 mg and midazolam 2 mg, as a premedication, were intramuscularly injected. The patient's blood pressure was 130/90 mmHg and heart rate was 72 beats per min (BPM) prior to the surgery. As the patient arrived at the operation room, we installed a pulse oximetry and an automated non-invasive manometer. After attachment of an EKG, we continuously checked lead II to monitor heart rate for capturing any signs of development of arrhythmia. Anesthesia was induced with 120 mg of propofol, an induction agent, following the injection of 30 mg of lidocaine in an attempt to avoid pain caused by propofol. Rocuronium 70 mg was administered for tracheal intubation. Anesthesia was maintained with a mixture of nitrous oxide (60%) and sevoflurane (1–3%) in oxygen. When required, supplemental sevoflurane was administered. After the induction of general anesthesia, cefazolin 2.0 g was given intravenously.

The patient's ventilation was monitored through the end-tidal carbon dioxide ( $ET_{CO_2}$ ) measurement device. We also used control ventilation to maintain the patient's end-tidal carbon dioxide level between 30 and 40 mmHg.

The patient was placed in the beach chair position at 70° of flexion. After preoperative physical examination and orthopedic disinfection, the shoulder joint was examined for any intra-articular pathology through a standard posterior portal while intra-articular irrigating fluid (0.3 mg of epinephrine mixed to 1 L of normal saline) was infused. At the time of stab incision of the skin to establish an anterior portal (at 35 min after induction of general anesthesia, 25 min after change to the beach chair position, and 5 min after infusion of epinephrine saline irrigation through a posterior portal, approximately 900 mL of irrigation fluid had been infused), paroxysmal supraventricular tachycardia (PSVT) developed abruptly. The procedure was aborted, the arthroscopic irrigation was discontinued, and the portal sites were cleared. As the PSVT was followed by ventricular tachycardia, the patient was immediately positioned to supine. However, the patient's blood pressure could not be measured and the peripheral pulse was not palpable. We had no enough time to find out the exact cause of it and to use any antiarrhythmic drugs. Immediate cardiopulmonary resuscitation was performed. After that, the cardiac rhythm was restored to normal, but dopamine was immediately infused and maintained at 10 µg/kg/min because the blood pressure was persistently low. Pulmonary edema was suspected as pink frothy

secretion was coming out from the endotracheal tube, which was managed with furosemide 20 mg intravenously after radiographical confirmation. The emergent bedside echocardiogram demonstrated decreased ventricular ejection fraction to 39% with global hypokinesia but without air bubbles in the circulation. The patient was transferred to the surgical intensive care unit and cardiology consultation obtained for further management. The EKG performed in the intensive care unit did not demonstrate any abnormalities in both T-wave and ST-T segment, but serum cardiac enzyme levels were mildly elevated: CK-MB, 10.4 (0.6–6.3 ng/mL); myoglobin, 911.6 (17.4–105.7 ng/mL); and troponin-I, 0.68 (<0.04 ng/mL). As the blood pressure tended to stabilize from 1 day after surgery, infusion of cardiac iatrogenic agents was reduced under monitoring. The echocardiogram, performed 5 days after the development of ventricular tachycardia, did not reveal any abnormal findings. The patient was discharged home on the eighth postoperative day.

## Patient 2

A 49-year-old woman (weight: 52 kg, body mass index: 23.1), who had complained of pain and weakness in the left shoulder, was scheduled for an arthroscopic rotator cuff repair with the diagnosis of rotator cuff tears. There were no abnormal findings in preoperative examinations and her history. The same preoperative treatment and induction of anesthesia were performed as the prior patient. The patient's blood pressure was 140/80 mmHg and heart rate was 68 BPM before surgery.

During arthroscopic examination of the shoulder joint while infusing the irrigating fluid through a posterior portal, with the patient placed in the beach chair position at 70° of flexion, PSVT was developed abruptly at 35 min after induction of general anesthesia, 25 min after change to the beach chair position, and 5 min after infusion of epinephrine saline irrigation through the posterior portal. The patient was immediately positioned to supine. Then, 50 mg of lidocaine was injected intravenously and cardioversion was performed two times. The EKG was restored to normal but ventricular tachycardia followed. The cardiac rhythm was normalized only after three times of additional cardioversion. The patient was transferred to the intensive care unit and dopamine was continuously infused 10 µg/kg/min to maintain the blood pressure. The emergent bedside echocardiogram demonstrated decreased ventricular ejection fraction to 30% with global hypokinesia but without air bubbles in the circulation. After 5 days of treatment in the intensive care unit, the patient was transferred to the general ward. The patient was discharged home as the echocardiogram performed on the 12th day did not demonstrate any abnormalities.

In the case of the second patient, 900 mL of irrigation fluid remained after surgery and the infusion pump used were sent to the laboratory on the day of surgery for detection of epinephrine, but there was no epinephrine left.

#### Observation of epinephrine flow pattern

The only change we made to our routine surgery before development of ventricular tachycardia in the above two patients was the addition of 0.3 mL of epinephrine to a 1-L plastic bag of normal saline instead of a 3-L bag. We assumed that when a 1-L bag was connected to an infusion pump without properly mixing epinephrine, highly concentrated epinephrine was likely to be infused rapidly into the joint. To prove the assumption, we injected 0.3 mL of epinephrine and 1 mL of gentacin violet reagent into a 1-L plastic bag of normal saline, connected it to the infusion pump used for arthroscopic surgery, and observed the pattern of epinephrine flow in the bag. When the bag was sufficiently shaken after epinephrine was injected, the gentacin violet reagent spread evenly, making the overall color of the bag light blue. However, when the bag was insufficiently shaken, a dark blue pattern was locally seen around the intake of the plastic bag of normal saline (Fig. 1a, b). In addition, the well-shaken bag evenly sent out the light blue colored fluid when connected to the infusion pump, but the poorly shaken bag drove out the blue-patterned fluid rapidly through the outlet as soon as the infusion pump was put to work (Fig. 2a, b).

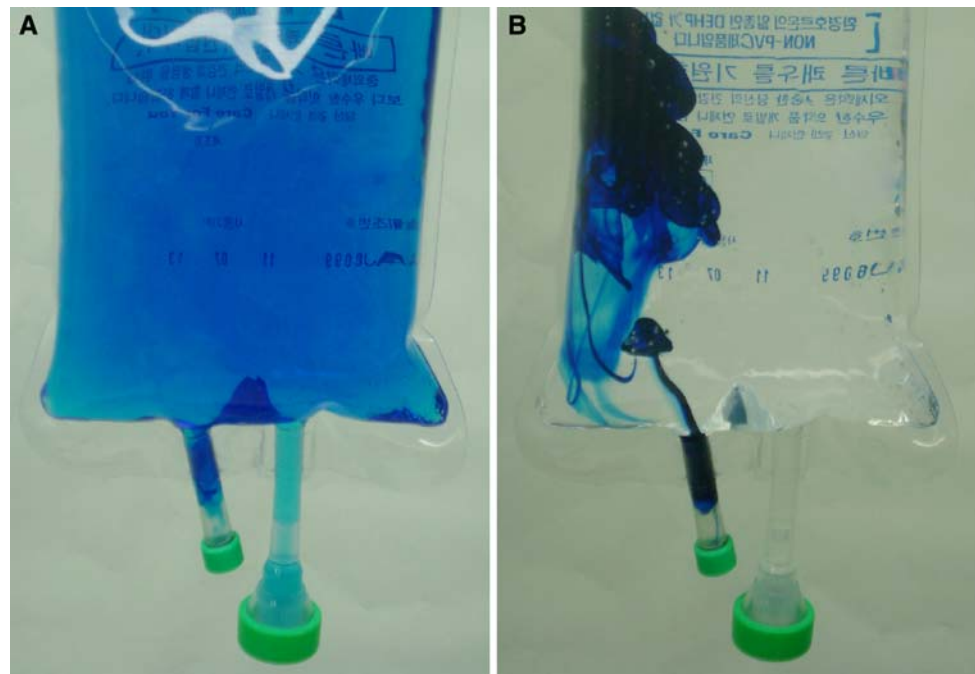
#### Discussion

When unexplained ventricular arrhythmia and cardiac collapse are abruptly developed during shoulder arthroscopic surgery in a patient placed in the beach chair position under general anesthesia, anaphylactic or type-I hypersensitivity reactions to the agents used, venous air embolism, or epinephrine-induced cardiovascular complications are potential candidates for the cause of sudden cardiovascular dysfunction.

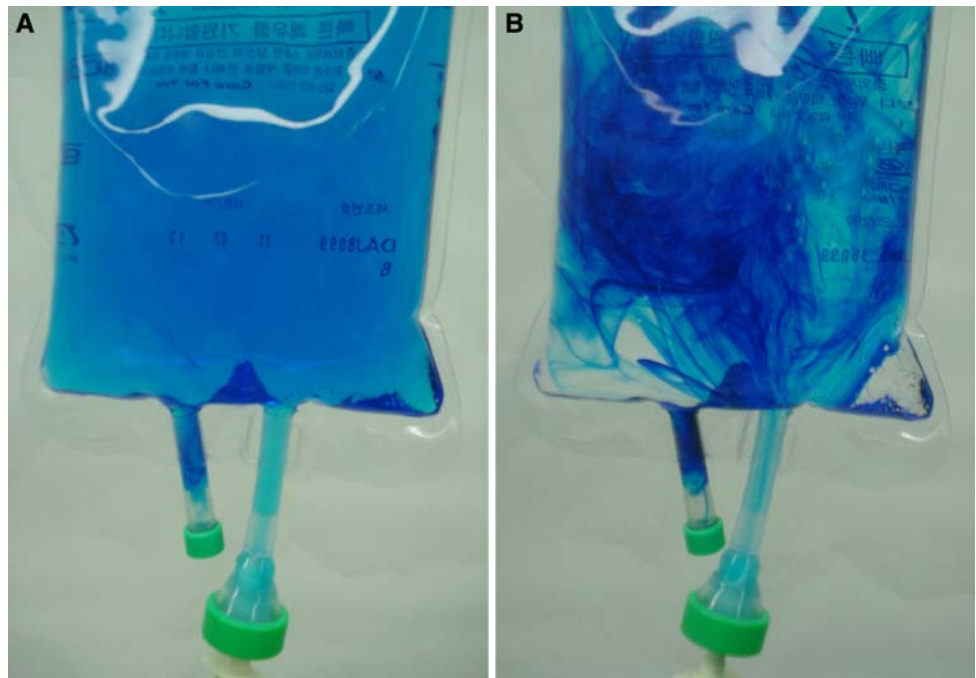
Anaphylactic reactions are typically associated with dermatitis, angioedema, or bronchospasm, but the two patients described above did not manifest any of those symptoms nor have history of allergic reactions, which made us exclude anaphylactic reactions as the cause of ventricular arrhythmia and cardiac collapse.

In the beach chair position, an operative site is placed higher than the right atrium, increasing the risk of venous air embolism when a vein is punctured during insertion of an arthroscope. In many cases, venous air embolism presents ventricular tachycardia on EKG and accompanies decreased end-tidal carbon dioxide, hypoxemia, and hypercapnia. Air bubbles may also be detected in the circulatory system by echocardiogram [5]. The two cases in this article showed a decreased ventricular ejection fraction with global hypokinesia on echocardiogram, but demonstrated neither a decrease in  $ETCO_2$  nor air bubbles. In addition, ventricular tachycardia and cardiac dysfunction developed approximately 25 min after the patients were located in the beach chair position. In previous case reports

**Fig. 1** When the bag was sufficiently shaken (a), the gentacin violet reagent spread evenly and then the overall color of the bag was light blue, and when insufficiently shaken (b), a dark blue colored lump was shown locally around the intake of the bag



**Fig. 2** When each bag was connected to the infusion pump, **a** the well-shaken bag evenly sent out the light blue colored fluid and **b** the poorly shaken bag showed different pattern of outflow



on air embolism developed after shoulder arthroscopic procedures [1, 2], 50 mL of air was commonly used as a joint distending agent. Taking all the factors above into consideration, it was difficult to point venous air embolism as the cause.

As seen from the epinephrine flow pattern in a well-shaken and a poorly shaken 1-L plastic bag of normal saline, unevenly diluted epinephrine may flow into the vein as soon as the infusion pump is put to work, even though the bag is not sufficiently shaken. This increases the risk of serious complications such as ventricular arrhythmia and cardiac collapse. Furthermore, epinephrine could not be detected from the irrigation fluid that remained in the infusion tube used in the second patient because of rapid outflow of highly concentrated and poorly mixed epinephrine in the normal saline bag when the infusion pump was at work. Therefore, we concluded that the ventricular arrhythmia and cardiac compromise were attributable to the highly concentrated epinephrine in the irrigation fluid. Further experiments to confirm what we have observed will be needed.

At the time of arthroscopic shoulder surgery, it is very important to ensure proper preparation of the epinephrine irrigation fluid so that an inappropriate dose of epinephrine is not administered. More importantly, particular attention

should be paid in case of intra-articular hemorrhage as epinephrine gains rapid access to the venous circulation through a ruptured microvasculature.

In addition, we should be aware and cautious of the development of epinephrine-induced cardiovascular complications for early diagnosis and subsequent management although it is very uncommon.

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