Clinical Case Report

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Coronary artery spasm induced by carotid sinus stimulation during arthroscopic shoulder surgery

A case report

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Abstract

Rationale: Variant angina is characterized by coronary artery spasm irrespective of the presence of fixed stenotic coronary lesions. Perioperative coronary artery spasm may be induced by the supersensitivity of vascular smooth muscle cells caused by various stimuli, including stimulation of the parasympathetic nervous system.

Patient concerns: A 57-year-old male patient was undergoing arthroscopic rotator cuff repair under combined interscalene brachial plexus block and general anesthesia in the lateral decubitus position. While compressing the right shoulder to remove residual irrigation fluid in the shoulder through the surgical site, ventricular fibrillation occurred without ST elevation.

Interventions: The patient achieved a return of spontaneous circulation after chest compression, defibrillation, and an epinephrine infusion.

Diagnosis: Postoperative coronary angiography showed no significant stenosis, but it did show that the right coronary artery contracted rapidly and was completely obstructed after an intravascular injection of ergonovine, and that the contracted area returned to its normal size after nitroglycerin was injected into the coronary artery. Based on these observations, the patient was diagnosed with variant angina.

Outcomes: The patient was discharged on postoperative day 20 without any sequelae and is currently under follow-up in the Cardiology Department.

Lessons: Surgeons should be vigilant and take relevant precautions, as compressing the shoulder to remove residual irrigation fluid during arthroscopic shoulder surgery in the lateral decubitus position may stimulate the carotid sinus and cause coronary artery spasm.

Abbreviations: BIS = bispectral index, CPR = cardiopulmonary resuscitation, ECG = electrocardiogram, ETCO2 = end tidal CO2 tension, ICU = intensive care unit, POD = postoperative day, ROSC = return of spontaneous circulation.

Keywords: angina, arthroscopy, coronary vasospasm, shoulder

1. Introduction

Variant angina is a clinical condition first described by Prinzmetal et al[1] that is characterized by coronary artery spasm regardless of the presence of fixed stenotic coronary lesions. During surgery, variant angina may occur during both general[2] and regional anesthesia.[3] It may occur during surgery and anesthesia even in patients with normal coronary artery structures.[4,5]

Perioperative coronary artery spasm may be induced by the supersensitivity of vascular smooth muscle cells caused by various stimuli, including stimulation of the parasympathetic nervous system.[6] There are reports of coronary artery spasm being caused by carotid artery stimulation during carotid sinus massage and neck surgery.[7,8]

This case report contains a description of coronary artery spasm caused by carotid sinus stimulation while compressing the right shoulder to remove residual irrigation fluid during arthroscopic shoulder surgery in a patient not diagnosed with variant angina. In addition to a description of this incident, we include a review of pertinent literature.

2. Case report

The written informed consent was obtained from the patient for publication of this case report and accompanying images. A 57-year-old male patient (weight: 73 kg, height: 163 cm) was admitted with a diagnosis of a rotator cuff tear in the right shoulder. He had no notable medical history and his blood tests, electrocardiogram (ECG), and chest radiography findings were normal. The patient was scheduled to undergo arthroscopic

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This case is not a clinical trial and just incidental interventional process so ethical approval was not necessary.

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rotator cuff repair in the lateral decubitus position under combined interscalene brachial plexus block and general anesthesia.

The patient received an intramuscular infusion of glycopyrrolate (0.2 mg) 30 minutes prior to arriving in the operating room. After arriving in the operating room, ECG, noninvasive blood pressure, pulse oxygen saturation, and bispectral index (BIS) values were measured. The patient had an ECG that showed normal sinus rhythm, a blood pressure of 150/88 mmHg, a heart rate of 78 beats/min, pulse oxygen saturation of 100%, and a BIS value of 99.

The patient was placed in the supine position with his neck rotated slightly to the left. After sterile preparation and draping of the right side of the neck, the round or oval hypoechoic trunk was identified between the anterior and middle scalene muscles using ultrasound. The interscalene brachial plexus block was performed with a 23 G needle using an in-plane approach, and a perineural solution of 15 ml of 0.375% ropivacaine was injected slowly after negative aspiration. After injection of the perineural solution, the patient had an ECG that showed normal sinus rhythm, blood pressure of 167/82 mmHg, heart rate of 62 beats/min, pulse oxygen saturation of 100%, and a BIS value of 99.

General anesthesia was induced 10 minutes after the interscalene brachial plexus block with 1% lidocaine (40 mg) and propofol (120 mg). After confirming loss of consciousness, rocuronium (50 mg) was intravenously infused and intubation was performed 2 minutes later. Anesthesia was maintained with sevoflurane 2 to 3 vol%, O_2 2 L/min, and air 2 L/min, and mechanical ventilation was performed with a tidal volume of 550 ml and a breathing rate of 12 breaths/min.

After general anesthesia was induced, the patient was moved from the supine position to the left lateral decubitus position. Surgery began 25 minutes after inducing general anesthesia. The patient had an ECG showing normal sinus rhythm during surgery, blood pressure of 97–120/51–75 mmHg, heart rate of 59 to 66 beats/min, oxygen saturation of 99% to 100%, end tidal CO_2 tension ($ETCO_2$) of 31 to 35 mmHg, and BIS of 36 to 41.

About 2 hours into the surgery, the surgeon compressed the patient's right shoulder with both hands to remove residual irrigation fluid before suturing the surgical site. During compression of the shoulder, ventricular fibrillation occurred suddenly on the ECG. The patient was immediately shifted to the supine position and cardiopulmonary resuscitation (CPR) was initiated. Four minutes after beginning CPR, defibrillation was performed with 200 J and a return of spontaneous circulation (ROSC) was achieved. At the time, the patient had a blood pressure of 96/71 mmHg, heart rate of 82 beats/min, oxygen saturation of 99%, and $ETCO_2$ of 28 mmHg. Artery cannulation was performed on the left radial artery to monitor the patient's blood pressure continuously and to conduct an arterial blood gas analysis, and a central venous catheter was placed in the right jugular vein for continuous intravenous infusion of isosorbide dinitrate (0.5 μg/kg/min). Four minutes after obtaining ROSC, ventricular fibrillation occurred again. Defibrillation was performed with 200 J followed by CPR and an intravenous infusion of epinephrine (1 mg). The ECG did not change, so four cycles of defibrillation (200 J), 2 minutes of CPR, and an intravenous epinephrine (1 mg) infusion were applied. ROSC was achieved 19 minutes after the second ventricular fibrillation. Chest radiography performed after ROSC showed pulmonary edema in both lungs. Echocardiography showed normal ventricular contractions without abnormal regional wall motions, and that the chambers were of normal size and thickness. Capnography showed spontaneous breathing and indicated that the BIS had increased to 79, so rocuronium (10 mg) and dexmedetomidine (10 ml/h) were continuously infused intravenously. For 30 minutes after achieving ROSC, the patient's invasive blood pressure was 105–157/68–94 mmHg, his heart rate was 90 to 144 beats/min, his oxygen saturation was 64% to 82%, and his $ETCO_2$ was 35 to 44 mmHg. After the surgical site was sutured, the patient was transferred to the intensive care unit (ICU) without removal of the tube.

The patient received a continuous infusion of norepinephrine (0.6 μg/kg/min) in the ICU and was placed on mechanical ventilation to maintain mandatory ventilation mode with a fraction of inspired oxygen of 100%, a tidal volume of 500 ml, and a respiratory rate of 20 breaths/min. The patient's complete blood count results were hemoglobin 15.9 g/dl, hematocrit 47.2%, and platelets 399,000/μl. His myocardial enzyme levels were CK-MB 3.20 ng/ml and troponin T 0.019 ng/ml, both of which were within the normal range. After 5 hours in the ICU, the patient recovered consciousness to the point of being able to communicate. His vital signs were unstable, so a norepinephrine infusion and mechanical ventilation were continued. Extubation was performed on postoperative day (POD) 7 and the patient was transferred to the general ward on POD 9. In a later consultation with a cardiologist, the patient mentioned having chest pains the day after drinking, so he was prescribed coronary angiography. Coronary angiography showed no significant stenosis, but the right coronary artery contracted rapidly and was completely obstructed after an intravascular injection of ergonovine. The contracted area returned to its normal size after nitroglycerin was injected into the coronary artery (Fig. 1). The patient was diagnosed with variant angina. He was discharged on POD 20 without any sequelae and is currently on follow-up at the Cardiology Department.

3. Discussion

Coronary artery spasm, which causes variant (Prinzmetal) angina, is the sudden, transient focal vasospasm of the hypersensitive endothelium of the coronary arteries. It has been reported to occur even in patients with normal coronary artery structures.[4,5] It may occur during both general[2] and regional anesthesia[3] and may cause acute myocardial infarction, an atrioventricular block, asystole, and ventricular tachyarrhythmias.

Causes of perioperative coronary artery spasm include the redistribution of blood flow,[9] altered humoral factors,[10] increased catecholamine responses secondary to the level of anesthesia,[11] and an imbalance in vasoconstrictor-vasodilator forces.[10,11] It is also suspected that parasympathetic nervous system stimulation may cause coronary artery spasm.[6] Yasue et al[12] reported that an intracoronary injection of acetylcholine induced coronary vasospasm, although this effect could be blocked by premedication with atropine. Therefore, increased parasympathetic activity may induce coronary vasospasm. Nishizaki et al[7] reported that coronary artery spasm was confirmed by angiography to have occurred owing to carotid sinus massage in a conscious patient without coronary artery stenosis. Choi et al[8] reported that carotid sinus stimulation during neck surgery under general anesthesia induced coronary artery spasm in a patient without a history of coronary artery disease.

In the present case, ventricular fibrillation occurred in a patient without a history of coronary artery disease when the shoulder was compressed to remove residual irrigation fluid during

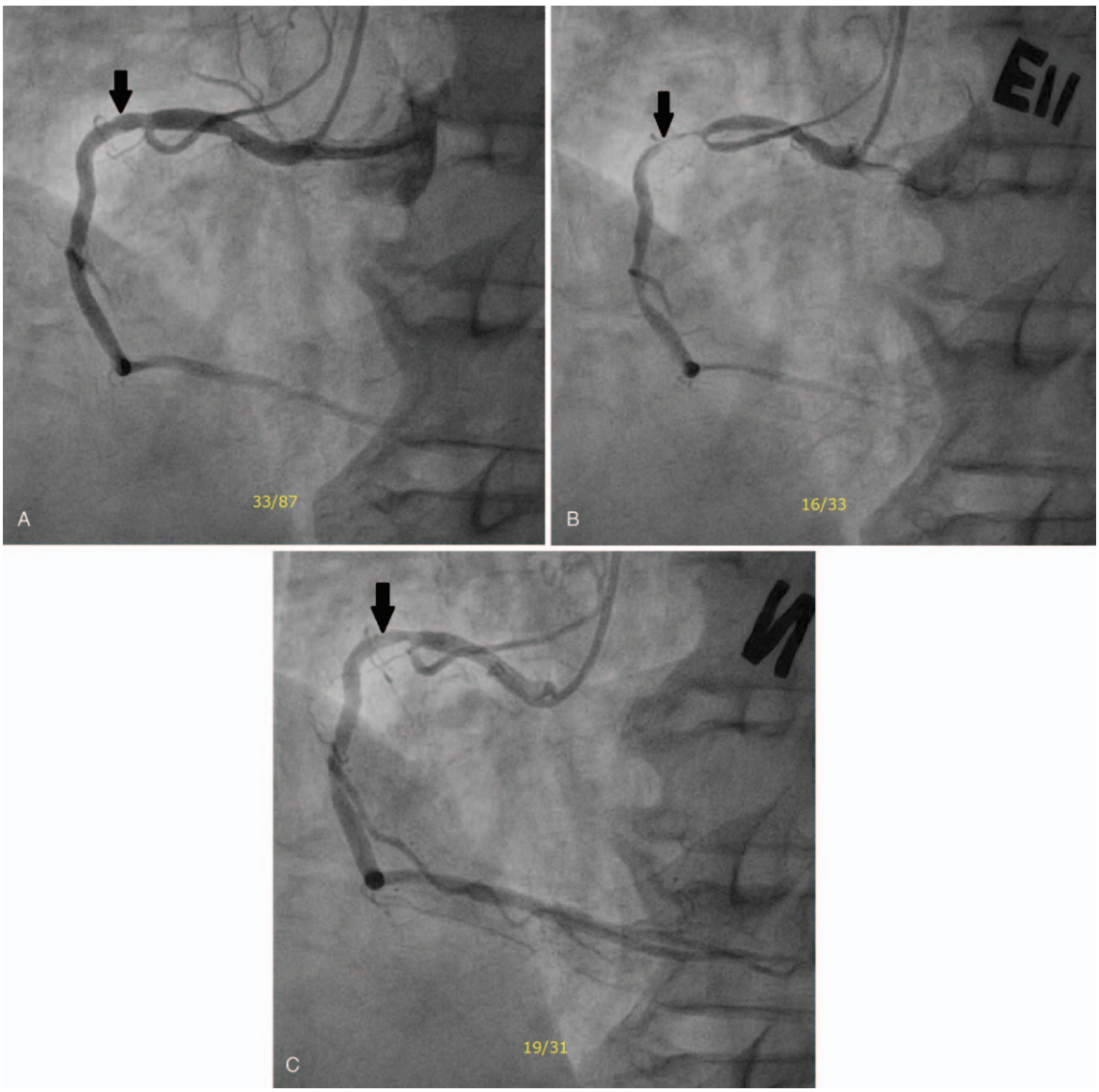

Figure 1. Coronary angiography on postoperative day 10. (A) Coronary angiography showed no significant stenosis in the right coronary artery. (B) The proximal portion of the right coronary artery was completely occluded after the intravenous administration of ergonovine (each dose, 10 μg). (C) The spasm was relieved after intracoronary nitroglycerin.

arthroscopic shoulder surgery in the lateral decubitus position under combined interscalene brachial plexus block and general anesthesia. During shoulder arthroscopic surgery, compressed irrigation fluid expands the joint space and improves the surgical field of view, but it tends to spread to the proximal soft tissues, including those in the neck, face, and chest. Gupta et al[13] reported that neck circumference increased significantly by 2.35 ± 1.9 cm (mean ± standard deviation) over the baseline value when the irrigation fluid pump pressure and flow rate were set to 40 to 80 mmHg and 50 to 150 ml/min, respectively, in the lateral decubitus position. In the lateral decubitus position, extravasation of irrigation fluid to nearby soft tissue may induce airway edema, tracheal compression, and complete airway obstruction.[14,15] Hynson et al[14] hypothesized that complete airway obstruction occurred as a result of fluid accumulation in the soft tissues of the neck owing to gravity while in the lateral decubitus position. In the present case, it is speculated that coronary artery spasm occurred as a result of compressing the shoulder while irrigation fluid was accumulated in the soft tissues of the neck owing to gravity in the lateral decubitus position, which resulted in the fluid stimulating the carotid sinus.

Variant angina may be diagnosed based on the typical ST-segment elevation on an ECG during an attack. However, there has been at least 1 report of ventricular tachycardia and fibrillation occurring without ST-segment elevation.[16] Similarly, in the present case, ventricular fibrillation occurred without ST-segment elevation. Furthermore, no coronary artery spasm could be detected early because the patient did not have any history of heart disease.

In conclusion, surgeons should be aware of the risk that compressing the shoulder to remove residual irrigation fluid during arthroscopic shoulder surgery in the lateral decubitus position may stimulate the carotid sinus and induce coronary artery spasms.

Author contributions

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