Clinical Case Report

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Severe hemodynamic instability after indocyanine green injection during off-pump coronary artery bypass grafting

A case report

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Abstract

Rationale: The increasingly intraoperative use of indocyanine green (ICG) means that it is necessary to be aware of both its advantages and potential adverse effects.

Patient concerns: A 76-year-old woman developed symptoms of sudden severe hemodynamic instability while undergoing coronary artery bypass grafting with ICG injection to detect the patency of the graft. The main clinical manifestations were a sudden drop in blood pressure and increased heart rate.

Diagnoses: Severe side effects or allergic reaction of ICG.

Interventions: Cardiopulmonary bypass (CPB) was established, and an intra-aortic balloon pump was implanted in the left femoral artery after intravenous epinephrine and manual cardiac compression failed.

Outcomes: The patient was extubated and transferred to the general ward on the third postoperative day.

Lessons: Invasive blood pressure monitoring should be carried out in patients undergoing intraoperative ICG administration. Anesthetists should pay close attention to the patient's hemodynamic fluctuations, and effective emergency measures should be implemented immediately if severe hemodynamic instability occurs.

Abbreviations: BP = blood pressure, CABG = coronary artery bypass grafting, CPB = cardiopulmonary bypass, HR = heart rate, IABP = intra-aortic balloon pump, ICG = indocyanine green, ICGA = indocyanine green angiography.

Keywords: case report, coronary artery bypass grafting, hypotension, indocyanine green

1. Introduction

Coronary artery bypass grafting (CABG) is frequently associated with recurrent angina as a result of graft occlusion or stenosis. Intraoperative visualization using indocyanine green (ICG) angiography (ICGA) allows intraoperative assessment of the patency of the bypass graft and quality of the anastomosis, and directs graft revision, thus reducing the early-failure rate of bypass surgeries and the incidence of postoperative complications.[1,2] Moreover, ICGA can evaluate blood flow to the intestines and peripheral arteries during cardiovascular surgery, thus allowing the real-time detection of signs of organ ischemia.[2] Yamamoto et al[3] pointed out that intraoperative ICGA could accurately predict graft patency 1 year after CABG. These benefits mean that ICGA has attracted increasing attention in recent years. Indeed, 1 report suggested that intraoperative ICGA was of significant value in all vascular bypass surgeries.[4]

Nevertheless, few studies have reported on the adverse effects of ICG. The adverse reactions to ICG are similar to those of other types of contrast agents.[5] Hope-Ross et al[6] reported that abnormal liver or kidney function was a risk factor for adverse reactions. Patients should thus be confirmed to have no allergies to iodine or seafood or other serious allergies, and should also undergo careful assessments of liver and kidney functions before the administration of ICG.

2. Case presentation

A 76-year-old woman (body weight 70 kg) with coronary heart disease (unstable angina) was scheduled for off-pump CABG under general anesthesia. Her preoperative cardiac function was evaluated as Class I according to Killip classification criteria. Echocardiography showed thinning and motion abnormalities of the regional left ventricular wall, slight expansion of left ventricular apex, mildly elevated pulmonary artery pressure, and

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The publication of this case report was in accordance with the Declaration of Helsinki and approved by the ethics committee of the First Affiliated Hospital of China Medical University.

Written informed consent for the publication was obtained from the patient of this case report and any accompanying images.

All data are available in the manuscript.

The authors declare that they have no competing interests.

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Figure 1. Ready for ICGA (A), ICGA in progress (B, C).

left ventricular ejection fraction of 54%. She denied any history of liver or kidney disease or allergies to food, drugs, or contrast media. Laboratory tests indicated normal liver and renal functions, and no significant abnormalities were detected in any other tests.

Baseline blood gas analysis with electrolyte and glucose measurements before surgery were within normal limits. Anesthesia was induced with etomidate (0.2 mg/kg), midazolam (0.1 mg/kg), sufentanil (0.3 μg/kg), cisatracurium (0.15 mg/kg), and lidocaine (1.5 mg/kg) to facilitate tracheal intubation. A 20-gauge left radial artery catheter and a triple-lumen right internal jugular central venous catheter were inserted for dynamic monitoring of arterial blood pressure (BP) and central venous pressure. Monitoring also included an electrocardiogram and bispectral index. Anesthesia was maintained with 1% propofol (60 μg/kg/min) and dexmedetomidine (0.03 μg/kg/min). Thereafter, cisatracurium (0.15 mg/kg) was added every other hour. Heparin (100 mg) was given before dissecting the internal mammary artery. The patient's hemodynamics remained within an acceptable range [BP 100–140/60–85 mm Hg and heart rate (HR) 40–60 beats per min (bpm)] during these procedures.

The surgeon requested ICG injection for video angiography to detect the patency of the bridge after completion of bypass, and 5 mg ICG diluted in sterile water (10 mL) was injected through the central venous catheter (Figs. 1 and 2). Three minutes later, 50 mg protamine (1:0.5) was prepared to reverse the effects of the heparin, but before its administration, her BP dropped suddenly from 125/75 to 50/40 mm Hg, and her HR increased from 58 to 98 bpm (Fig. 3). There were no significant alterations in her electrocardiogram or evoked potentials. Intravenous epinephrine (100 μg) was injected immediately, with little effect on her BP and HR. The surgeon opted to perform manual cardiac compression, which also had little effect. Heparinization was repeated and emergency intubation was manipulated in the ascending aorta and right atrium to establish cardiopulmonary bypass (CPB), and an intra-aortic balloon pump was implanted in the left femoral artery. The patient's hemodynamics finally stabilized after 40 minutes, and the perfusionist successfully took off the pump. The operation was finally completed with the help of a pacemaker (80 bpm), and intravenous infusion of adrenaline (0.08 μg/kg/min) and norepinephrine (0.09 μg/kg/min) via a micro-pump, with her HR maintained at 80 to 90 bpm and BP at 85 to 100/45 to 65 mm Hg. Furosemide (10 mg) was given in light of her significantly reduced urine volume during CPB. The patient had been covered with surgical drapes during the operation, and these were removed after the emergency procedure, but no soft tissue swelling or rash was detected. The patient was returned to the intensive care unit with endotracheal intubation, for further observation after surgery.

Her vital signs at 7:00 AM the day after surgery were temperature 37.7°C, breathing rate 18 breaths/min, HR 80 bpm, and BP 120/65 mm Hg. The patient was extubated and transferred to the general ward on the third postoperative day.

The patient provided their consent for publication of this report.

3. Discussion

Fox and Wood first described the physical and physiological characteristics of ICG in 1960. It is a near-infrared, 3-carbon cyanide fluorescent dye (molecular formula: $C_{43}H_{47}N_2NaO_6S_2$) with an average half-life of 3 to 4 minutes. It rapidly combines with α1-lipoprotein within 1 to 2 seconds after intravenous injection, and remains intravascular with normal vascular permeability.[7] The principle of ICGA imaging involves projecting a near-infrared laser onto the surgical zone; intravascular ICG is excited by the laser and emits a fluorescence signal that can be recorded after filtering out the ambient light and laser. The process takes <5 minutes.[3] We therefore decided to inject ICG intraoperatively in the current patient to assess the

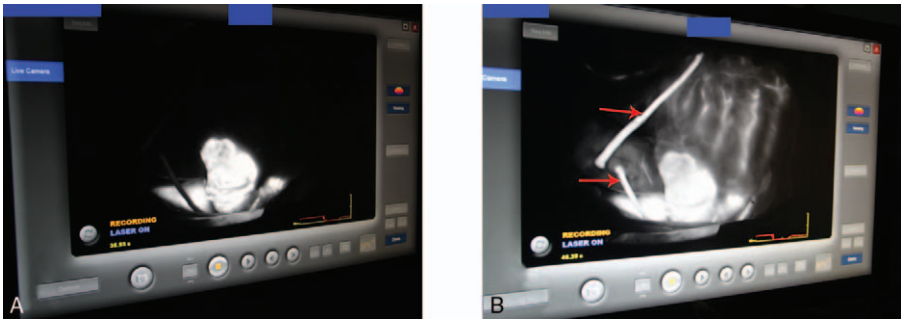

Figure 2. Imaging of the heart (A), Imaging of the graft vessel (arrow pointing position in picture B).

Figure 3. The anesthesia records of her (Changes in BP, HR before and after ICG injection in the red box).

patency of the bypass graft and the quality of the anastomosis, and to direct graft revision.

Anaphylaxis generally manifests as skin reactions (urticaria, flushing, etc.), and respiratory system (dyspnea, bronchospasm, cyanosis, etc.) and cardiovascular system responses (tachycardia, reduced BP, cardiac arrest). However, anaphylaxis is difficult to diagnose rapidly in a patient under general anesthesia: first, the diagnosis of allergic reactions relies largely on skin testing and detection of specific IgE in blood samples taken at the onset of allergic reactions; second, general anesthesia may alter the patient's sympatho-adrenergic response to acute anaphylaxis; and third, the early cutaneous signs of anaphylaxis may go unrecognized because the patient is under drapes, and usually unconscious or sedated.

In the current case, the emergency nature of the case meant that blood samples were not collected at the onset of her allergic reactions, and no soft tissue swelling or rash was detected; symptoms of cardiovascular collapse after ICG injection were the first recognized signs. And she denied allergic histories; hypovolemia and embolism were ruled out because of no massive bleeding and no obvious changes in SpO_2, end-tidal CO_2, and peak airway pressure. We therefore considered that these symptoms were likely to be side effects of or anaphylaxis related to ICG.

As early as 1996, Olsen et al[8] reported on 5 patients with hypotension or even undetectable BP, following the administration of ICG in ophthalmology. However, few reports have described any adverse reactions to this compound, let alone any lethal allergic reactions[9] or complications related to its use in cardiac surgery.

In a previous report, a patient received ephedrine and phenylephrine to treat severe hypotension caused by intraoperative ICG injection, with a favorable outcome.[10] In our case, however, immediate epinephrine injection and manual cardiac compression failed, and she underwent timely anti-shock treatment in the cardiac surgery room with CPB being ready for an emergency, with an ultimately good outcome. However, there was a debate about conducting CPB for anti-shock treatment. Then, other surgical procedures often do not have such intraoperative first aid measures such as cardiac surgery.

ICGA is being used increasingly to evaluate the intraoperative blood flow during neurological and oncological surgical procedures (e.g., gastric and breast cancer resection, etc.),[11–15] as well as in cardiology and ophthalmology. We therefore suggest that invasive BP monitoring should be carried out in all such patients receiving intraoperative ICG. Importantly, anesthetists should pay close attention to hemodynamic fluctuations, and effective emergency measures should be taken rapidly in the event of severe hemodynamic instability.

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