Massive systemic air embolism during off-pump coronary artery surgery

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Abstract

In OPCAB (off-pump coronary artery bypass) operations, development of cardiac arrest during the distal anastomosis to obtuse marginal coronary artery leads to significantly low blood pressure in the ascending aorta. Therefore, blowing of compressed air in high flow on not-slinged coronary artery may cause air mobilization from the coronary artery system into the ascending aorta that may result in severe brain damage.

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1. Introduction

The use of cardiopulmonary bypass (CPB) causes a systemic inflammatory response that plays a role in undesirable outcomes. Morbidity associated with this inflammatory response may involve various organs and systems such as heart, brain, blood, lung, kidney and gastrointestinal tract [1]. OPCAB operations are being performed with the option of coronary revascularization without the potential complications of CPB [2,3]. A major obstacle to the safe and accurate performance of coronary bypass grafting on beating heart is bleeding arising from the coronary arteriotomy [4]. Although the optimal method of arteriotomy visualization has not been identified yet, it has been suggested that a catheter-directed stream of compressed air, oxygen or carbon dioxide is helpful. These methods provide a dry field during distal coronary anastomosis, allowing clear visualization of the anastomotic suture line without halation. However, blowing of compressed air or oxygen into the coronary artery may cause embolic complications. Coronary artery embolism [5], left ventricular cavity air filling [6], massive pulmonary artery embolization during the repair of injured coronary vein [7] have been reported. Herein, we report a case of massive systemic air embolism during an OPCAB operation.

2. Case report

A 74-year-old man was admitted to our clinic with chest pain and progressive dyspnea on exertion. He had undergone stenting of circumflex coronary artery 6 months ago. Echocardiography revealed poor left ventricular function with a 37% ejection fraction. Coronary angiography showed 95% stenosis in proximal left anterior descending (LAD) artery, 95% stenosis in diagonal artery, and in-stent 70% stenoses in obtuse marginal artery. There were marginal irregularities without significant stenosis in the right coronary system. Patient was referred for surgery. Central venous line was inserted into internal jugular vein after general anesthesia. Median sternotomy was done and left internal thoracic artery (LITA) was harvested. However, flow of the LITA was extremely low and two segments of LITA were severely atherosclerotic. We decided to use saphenous vein as the conduit for LAD. Firstly, two proximal anastomoses of saphenous veins were done onto the ascending aorta. Then LAD and diagonal artery distal anastomoses were done using a stabilizer device (Axius Vacuum 2 Stabilizer System; Guidant, Santa Clara, California; or Octopus 3; Medtronic, Minneapolis, Minnesota; or Estech equipment) without any hemodynamic deterioration. The patient was placed in the Trendelenburg position and the heart was elevated with deep pericardial sutures to expose the obtuse marginal artery. Since satisfactory exposure of obtuse marginal artery could not be obtained, a Starfish™ device (Medtronic Inc., Minneapolis, MN) was applied. Systemic systolic artery pressure decreased to 75 mmHg without rhythm disorder. Coronary arterial sling was not done due to previously inserted stent and the calcification in the coronary artery. An arteriotomy on the obtuse marginal artery was done. Blowing of compressed air was used for optimal visualization (Fig. 1). This device delivers a constant jet of air to effectively clear blood from the anastomosis field. The cannula was kept at a distance of 5–10 cm from the coronary artery. The average flow of compressed air was 5 l/min and the average spray...
The Starfish™ and octopus devices were rapidly removed, anastomosis was rapidly completed in one and a half minutes. During the distal anastomosis to obtuse marginal artery, the pressure was 50 mmHg. Suddenly, a cardiac arrest developed.

Fig. 1. Octopus and Starfish™ devices were positioned. Cardiac arrest developed during the distal anastomosis to obtuse marginal artery. Last three sutures were inserted by blower assistance and then the devices were removed and internal cardiac massage was started. During the cardiac massage, massive air in all grafts and ascending aorta was noticed. Air was evacuated from grafts and ascending aorta by needle aspiration. But cerebral air embolism caused severe brain damage.

pressure was 50 mmHg. Suddenly, a cardiac arrest developed during the distal anastomosis to obtuse marginal artery. The anastomosis was rapidly completed in one and a half minutes. The Starfish™ and octopus devices were rapidly removed, the position of Trendelenburg was abolished and internal cardiac massage was started. Suddenly, ascending aorta and all coronary artery grafts were filled with air. The air was removed from ascending aorta and coronary grafts with needle. Massive air was evacuated from ascending aorta. Then we continued internal cardiac massage and obtained a satisfactory systolic blood pressure. Cardiac rhythm and contraction occurred 4 min after starting internal cardiac massage. Satisfactory cardiac performance was obtained by positive inotropic drugs. Proximal anastomosis of conduit to obtuse marginal artery was done on the conduit of diagonal artery. The operation was terminated in a standard fashion. Hemodynamic derangement during cardiac elevation continues to be a concern for high quality distal anastomosis. Hemodynamic derangement is much more common during lateral and posterior wall revascularization. Sometimes conversion to conventional CABG would be necessary. Blowing of compressed air or oxygen into the coronary artery may be hazardous because of the potential of producing air embolism. Therefore, low cardiac output states may occur due to coronary air embolism and these patients may require intra-aortic balloon pump due to hemodynamic derangement. Lee and colleagues [7] reported massive pulmonary embolism during the repair of a coronary vein during off-pump CABG surgery. In this report, possibly, massive air stream from blower went into the cardiac venous system, which did not have valve and stenosis, and also drains to relatively low pressured right atrium. To the best of our knowledge, our case is the first report of massive systemic air embolism during OPCAB in the literature. The mechanism of massive systemic air embolism in our case is similar to that in Lee et al.'s case report [7]. We think that cardiac arrest during the obtuse margin artery anastomosis severely decreased aortic pressure and high flow compressed air went into the coronary artery system through proximally not-slinged obtuse margin artery that had 70% in-stent stenosis. Then a huge amount of air in the coronary artery system shifted to the ascending aorta, which had low pressure due to cardiac arrest. Some surgeons have used carbon dioxide instead of compressed air because of CO₂ is 34 times more soluble than air in water [5]. Therefore, CO₂ gas trapped in any part of circulation is not likely to cause systemic embolism due to bubbles. Proximal arterial sling may prevent proximal coronary artery system embolization but Akhtar and colleagues [6] showed that left ventricular air bubbles come from thebesian veins drained to the left ventricle. Thus, these bubbles may cause systemic embolization.

3. Discussion

Off-pump CABG is a more demanding procedure than conventional CABG. Despite local tissue stabilization, the heart’s natural motion and potential for hemodynamic derangement during cardiac elevation continues to be a

References