CO₂ embolism during minimally invasive vein harvesting

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Abstract

CO₂ embolism is a known, though rare, complication of procedures using CO₂ insufflation. We report massive cardiac right atrial CO₂ embolism during minimally invasive harvesting of a varicose great saphenous vein. The patient’s hemodynamics deteriorated significantly and needed to be stabilized by emergency institution of cardiopulmonary bypass. Causes of this rare but potentially lethal complication are discussed, as well as its prediction, diagnosis, and prevention.

Keywords: Minimally invasive vein harvesting; CO₂ insufflation; Embolism; Complication varicosis

1. Background

Minimally invasive vein harvesting (MIVH) for coronary artery bypass grafting employing VasoView systems (Guidant Corp., Indianapolis, IN, USA) is an established procedure. This technique offers, beside superior cosmesis, faster postoperative mobilization, shorter hospital stays, reduced risk of infection and bleeding, and reduced postoperative pain [1—4], while at the same time causing less endothelial and smooth muscle cell damage [5]. The VasoView vessel harvesting system uses CO₂ insufflation to create a closed working tunnel for the preparation and harvesting of the great saphenous vein (GSV) or radial artery. The recommended CO₂ pressure is between 10 and 15 mmHg. The system allows harvesting of approximately 40 cm of vein or the full length of the radial artery through a 2 cm incision. Only rare cases of complications concerning CO₂ insufflation have been reported [6—8]. Severe CO₂ embolism necessitating emergency cardiopulmonary bypass occurred in a large study in 0.5% of patients [9]. We identified varicosis as a risk factor for CO₂ embolization.

2. Case report

A 72-year-old man who presented with coronary artery disease and unstable angina underwent urgent coronary artery bypass grafting. A physical examination showed varicosis of both GSV. MIVH (E.P.) was performed simultaneously with sternotomy and mammary artery take-down (S.B.) as part of our routine procedure. After the right GSV had been identified 2 cm below the tibial plateau through a 2 cm incision, the tubus was introduced into the working space subfascially and blocked. The vein was prepared while CO₂ insufflation maintained pressure in the tunnel of 12 mmHg. In the middle part of the upper leg a huge varicose knot was identified but was damaged during preparation. During attempts to stop the bleeding using bipolar cautery scissor scissors, the CO₂ pressure was increased to 16 mmHg to improve visibility. Some minutes later the anesthesiologist reported impairment of the patient’s hemodynamics shown by a marked increase in central venous pressure (CVP) from 5 to 23 mmHg. The function of the right ventricle was impaired. Because of hemodynamic deterioration an acute right heart infarction was suspected and preparations for emergency cardiopulmonary bypass installation were made. Unexpectedly, the enlarged right atrium was filled with gas. After incision of the right atrium to place the venous drainage a massive amount of gas escaped from the right atrium. The patient was brought into the Trendelenburg position, CO₂ insufflation was stopped, and inotropes were administered for hemodynamic support. Once the right atrium was free of gas the cardiopulmonary bypass was started to avoid gas bubbles entering the extracorporeal circuit. Additionally, an incision above the injured vein branch was performed and the varicose knot clamped, whereupon the patient’s hemodynamics rapidly improved and harvesting of the mammary artery was continued on cardiopulmonary bypass. No impairment of the gas exchange was seen and transesophageal echocardiography (TEE) performed immediately showed no connection between the right and left atria. The GSV was then harvested in open fashion and revealed severe varicose
knots but could be used for three grafts, and the left mammary artery was anastomosed as scheduled. The further course was uneventful, except for the transfusion of seven packs of red blood cells and eight units of fresh frozen plasma peroperatively. Cranial CT scan performed postoperatively revealed no brain damage.

3. Discussion

MIVH offers several advantages over open harvesting while providing grafts of similar quality. However, occasional complications have been reported, including hypercapnia, which is mostly related to resorption of CO₂ if high pressure or long harvesting time is necessary, and especially in patients with chronic obstructive pulmonary disease. Pressure between 10 and 12 mmHg is almost always sufficient to keep the tunnel open and to enable excellent visibility, independently of adipositas of the leg. In the present case the CO₂ entered the venous system and right atrium through the damaged varicose side branch. When the branches of the GSV are not varicose they can usually be sealed by bipolar cauterization. A damaged varicose knot does not collapse allowing CO₂ entrance if the working pressure overcomes the CVP. In this case the surgeon (E.P.) increased the CO₂ pressure to improve the diminished view, and this facilitated CO₂ entrance into the venous system. Chiu et al. showed significantly more CO₂ bubbles detected by TEE in the inferior caval vein during MIVH with working pressure of 15 mmHg [10]. Fortunately, the volume of gaseous CO₂ reaching the pulmonary artery in the presented case was not sufficient to produce a 'gas lock' effect. In such a case, cardiopulmonary bypass with venting of the pulmonary artery should be initiated immediately.

In conclusion, MIVH employing the VasoView system is an excellent technique with a low complication and similar patency and stenosis rate compared with open technique [11]. Based on our experience, harvesting of varicose vein is possible, but ultrasound studies should be performed to select the less damaged vein, the CO₂ pressure should not exceed 10—12 mmHg, and continuous TEE monitoring (although not used in the case of normal GSV) is necessary to detect CO₂ bubbles [10]. In the case of damage to the varicose vein or its branches, immediate cessation of CO₂ insufflation, Trendelenburg positioning of the patient, and hemostasis using an additional incision are essential to avoid CO₂ embolization, which might otherwise cause hemodynamic deterioration or even, in the case of patent foramen ovale with right-left shunt, systemic embolization [6].

However, severe varicosis may necessitate arterial revascularization with the endoscopically harvested radial artery and, if needed, the second mammary artery as an alternative to the GSV.

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References