CASE STUDY

Hemodynamic Monitoring and Fluid Management in Thoracic Surgery Requiring One-lung Ventilation

INTRODUCTION

Thoracic surgery frequently requires one-lung ventilation (OLV). Hemodynamic changes are significant during OLV and surgical manipulation and precise management of fluid administration is vital to postoperative recovery and surgical outcome. The FloTrac system, a minimally invasive hemodynamic monitoring device, with continuous cardiac output (CO) and stroke volume variation (SVV) is particularly useful in this patient population, especially during episodes of hemodynamic instability.

Patient details: 74-year-old, male, height: 178 cm, weight: 82 kg, 50 pack/year smoking history.

Medical history: Hypertension, hypercholesteremia, chronic obstructive pulmonary disease (COPD) with a FEV1 of 1.9 liters.

Figure 1

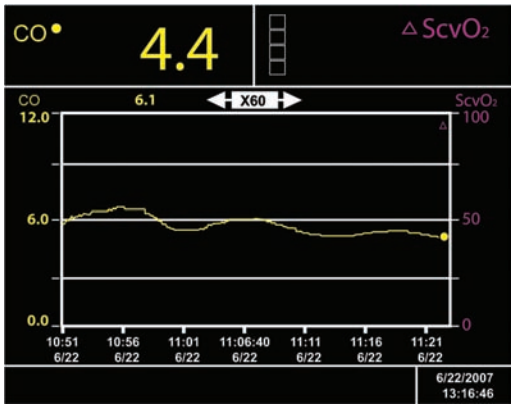

Figure 2

CASE NOTES

The patient was scheduled for a right upper lobectomy secondary to lung mass. His medical history was significant for hypertension, hypercholesteremia and COPD with a compromised pulmonary function. His electrocardiogram showed some ST-T depression on II, III, aVF with age undetermined. Pre-operative stress echocardiography could not be completed because of poor pulmonary function. Resting echo showed a left ventricular ejection fraction of 50%.

The patient was taken to the operating room where an 18 ga. IV and a thoracic epidural catheter were placed prior to induction of general anesthesia. General anesthesia was achieved using 2 mg of midazolam, 150 mg of propofol, and 80 mg of rocuronium, after which a double lumen endobronchial tube was placed and verified. Central venous pressure (CVP) was measured via CVC. The FloTrac system was connected by means of a radial intra-arterial catheter. At the time of

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the first measurement, the patient's heart rate (HR) was 82/min, blood pressure (BP) was 138/82 mmHg, central venous pressure (CVP) was 10 cmH_20, cardiac output (CO) was 5.5 L/min and stroke volume variation (SVV) was 10%. The patient was place in the right lateral position and OLV was established. There were no changes in CO or SVV from TLV to OLV.

Forty minutes into surgery, vital signs changed. The HR increased to 105/min, CVP decreased slightly to 8 cmH_2O, SVV increased to 31%, CO decreased to 4.0L/min (Figure 1) and there was an acute decrease in BP (95/58 mmHg). Acute hypovolemia was suspected and 500 ml of colloid solution was rapidly infused. There was an improvement in patient volume status and vital signs as shown in Figures 1, 2. The surgeon was informed of this finding. The tumor was found to be centrally located with adhesion to the right hilum. During the dissection of the tumor, the right upper pulmonary artery was injured and an approximate 600 ml blood loss occurred. At that time, bleeding was controlled with the surgeon's hand after which it was decided to perform right pneumonectomy because of the involvement of the tumor and the pulmonary artery injury. During the pneumonectomy, the SVV was maintained around 15%. The rest of the surgical procedure and hospital stay were uneventful. The patient was discharged home 7 days after surgery.

DISCUSSION

Major thoracic surgery usually requires OLV and involves major arteries and veins. A significant hemodynamic change could be potentially encountered during surgical manipulation. The immediate recognition of such events is pivotal to patient care and better surgical outcomes.

In this case, the FloTrac system demonstrated considerable utility in the event of significant blood loss during thoracotomy. During surgery when the major bleeding occurred, the changes in HR, BP, CVP and CO were not as significant as the change in SVV. Although CO was also slightly decreased, there was a significant increase in SVV (Figure 1). After taking all changes into consideration, especially the significant increase in SVV, the anesthesiologist was alerted to the possible rapid development of hypovolemia. After the fluid challenge, SVV decreased and CO increased while the other vital signs returned to baseline (Figure 2).

The SVV value is a sensitive indicator for probable decrease in circulatory blood volume. The combination of SVV with CO provided both an indication that fluid should increase SV (when SVV>15%), as well as a means of verifying that the fluid was in fact, beneficial to the patient's status (as seen by CO rising from 4.0 to 6.6).

In the event of lobectomy or pneumonectomy, our experience has shown that the SVV should be maintained around 15% to avoid fluid volume overload and the potential triggering of pulmonary edema.

From this case study, it was found that after the initiation of OLV, there were no changes in CO and SVV compared to TLV. Additionally, the sudden increase in SVV corresponded to an acute loss of circulatory volume and, therefore, titrating SVV to around 15% may be beneficial in lobectomy or pneumonectomy cases.

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Related Publications

1. Liu H, Konia M, et al. Does one lung ventilation affect stroke volume variation measurements during thoracic surgery? Anesthesiology 2007; 107:A1537.
2. Garutti I, Olmedilla L, et al. Hemodynamic effects of lidocaine in the thoracic paravertebral space during one-lung ventilation for thoracic surgery. J Cardiothorac Vasc Anesth 2006; 20(5):648-51.
3. Turner CR, Russell KY, et al. Variable systolic pressure variation and dynamic hyperinflation due to an intrabronchial tumor. J Clin Anesth 2004; 16(7):633-6.

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