The Use Of Continuous Mixed Venous Saturation Monitoring During Complex Peripheral Vascular Surgery

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Citation

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Abstract

Complex peripheral vascular surgical procedures often require invasive hemodynamic monitoring. Direct measurement of the arterial pressure is regarded as a necessity. However, it is not always possible to attain arterial access or even noninvasive blood pressure monitoring. When a complex case must be undertaken without the availability of arterial blood pressure monitoring, an alternative continuous monitor is advisable. Although it is seldom considered useful intraoperatively, mixed venous saturation (SvO2) is a continuous monitor of a patient's overall oxygen delivery status. We report two cases in which SvO2 monitoring was found to be efficacious in providing a continual assessment of our patients' conditions when arterial pressure monitoring was not feasible.
The patients were cared for at "The Ohio State University Hospital, Columbus, Ohio".

CASE 1

The patient was a 65-year-old female with a history of coronary artery disease (three myocardial infarctions, including one which had occurred two months earlier), chronic renal disease (which had resulted in the patient's dependence on dialysis for four years), insulin-dependent diabetes, and peripheral vascular disease. She presented with a cold, painful left foot requiring revascularization. The surgeon, the anesthesiology team, and the cardiology consultant agreed the patient would probably not tolerate cross clamping of her aorta, which would have been needed to bypass her stenotic left iliac and stenotic left popliteal arteries. A left axillary-femoral bypass was the next option; however, the patient's functioning dialysis shunt was in her left forearm. Surgery, proximal to the dialysis shunt, on the left axillary artery was not reasonable. A right axillary-femoral bypass was planned until the preoperative angiogram revealed significant stenosis of her right subclavian artery. The complex surgical procedure that was planned and accomplished, included the following bypasses done under general anesthesia: a right (R) carotid-subclavian, R axillary-femoral, R femoral-left (L) femoral, and L femoral-L popliteal.

Prior to induction of anesthesia, efforts were made to establish an arterial catheter. The right radial arterial pulse was barely discernible due to the nonfunctioning dialysis shunt in her right arm. Both right and left temporal arteries were palpated and percutaneous cannulation was attempted. This was unsuccessful on both sides, and the patient refused to have a surgical cut down at those sites. Eventually, a right radial catheter was inserted with the aid of a Doppler. This resulted in a very dampened waveform, although blood sampling was possible. A noninvasive blood pressure cuff was placed on the left arm. In view of her functioning shunt in that arm, the cuff was to be used only in an emergency. An initial blood pressure from that cuff was noted to be 76 mmHg higher than the right radial arterial pressure. Unfortunately, the differences between the two arms were not consistent. The few times the cuff was used, the pressure differential was between 10 and 80 mmHg. Also, the highest value from one arm was not obtained on the same measurement as the highest pressure from the other arm.

Standard monitors were employed, including a five-lead electrocardiogram (EKG) (viewing leads II and V5) with ST segment analysis, pulse oximeter (with a left ear probe), end tidal CO2 and agent analysis, esophageal stethoscope, and temperature probe. An oximetric pulmonary artery catheter was inserted percutaneously through the left internal jugular vein. The initial SvO2 was 68%.

The right radial arterial catheter was nonfunctional during several intervals of the case when the proximal subclavian artery was clamped. During one of those clamped periods, the SvO2 was noted to decrease from 73% to 60% over just a few minutes. The hematocrit and SpO2 were stable. No noticeable changes were apparent in the pulmonary capillary wedge pressure, electrocardiogram, ST segment analysis, or end tidal CO2. Blood was drawn for blood gas analysis, and cardiac output was determined. The only hemodynamic change found was a decline in the cardiac output from the previous measurement of 4.1 to 3.2 L/m. A dobutamine infusion was started at 2 ug/kg/min. This resulted in a cardiac output of 5.0 L/m and the venous saturation quickly increased to 75%. During the rest of the procedure and for the next two days in the intensive care unit, the SvO2 monitor was utilized to titrate pharmacologic support and ventilatory management. The patient was discharged from the intensive care unit on the third postoperative day with easily discernible pulses in her left foot.

CASE 2

This patient was a 69-year-old male who had recently undergone coronary artery bypass surgery. His postoperative course was complicated by renal failure. Two months after his heart surgery, he required urgent R axillary-femoral and R femoral-popliteal bypasses. He had a functioning dialysis shunt in his left arm. Monitoring plans included a right radial arterial catheter. We realized the signal would be lost during the period of axillary artery anastomosis. Upon the patient's arrival in the operating room, he was found to have an infiltrated intravenous line just proximal to his right elbow. This resulted in the loss of a palpable distal pulse. A Doppler examination did not reveal an ulnar, radial, or brachial pulse. The case proceeded after a noninvasive blood pressure cuff was placed on the left leg, and an oximetric pulmonary artery catheter was percutaneously inserted through the right internal jugular vein. After induction of general anesthesia, the staff surgeon arrived and announced the left leg needed to be prepped and included in the surgical field. The blood pressure cuff was removed and the case continued. Intermittent blood pressures were obtained with a cuff on the left arm above the dialysis shunt.

The operation lasted four hours, and the estimated blood loss was more than 700 mL. Fluid therapy, including the need for transfusions and ionotrophic support, was determined by the mixed venous saturation. After an estimated blood loss of approximately 500 mL, the venous saturation had declined from 77% to 65%. A unit of packed red blood cells was given, and the saturation rose to 74%. The pulmonary artery occlusion pressure had decreased only 2 torr over the same period, and the cardiac output had only declined from 4.8 to 4.4 L/min. The patient tolerated the procedure and the immediate postoperative course without significant problems. Postoperatively, therapy continued to be guided by the data available from the oximetric pulmonary artery catheter (PAC).

DISCUSSION

Current anesthesia literature would indicate that oximetric PACs are not fully utilized during anesthesia. Intraoperative values of SvO2 are routinely well above normal.([1,2]) This is presumably due to the increased FiO2 and the anesthetic-induced decreased metabolism or the inability of tissues to extract oxygen. 1,2 Under general anesthesia, patients may have mixed venous saturations near or above 90%. At that level, small changes in the partial pressure of oxygen in the pulmonary artery will not be indicated by discernable changes in the saturation. At a normal mixed venous partial pressure oxygen of 40 torr and saturation of 75%, small changes in the oxygen tension will be easily noted with the corresponding changes in the saturation. As our cases showed, patients in poor cardiovascular condition may not have abnormally high venous saturations while undergoing anesthesia and surgery.([3]) Thus, changes in the cardiovascular status of our patients were easily reflected by changes in the mixed venous saturation. We were able to take advantage of this situation and safely monitor our patients through difficult surgical procedures.

The SvO2 is dependent on several variables. Changes in hemoglobin, cardiac output, arterial saturation, or tissue oxygen requirements can result in changes in the mixed venous saturation.([4,5,6,7]) As such, it is not a very specific indicator of a patient's condition. As noted above, in many circumstances during anesthesia, the mixed venous saturation is not a very sensitive indicator of a patient's condition.([8]) In reality, very few of our monitors are truly specific. The pulse oximeter may indicate a drop in arterial saturation, however, this could be due to a low inspired oxygen, a decrease in cardiac output, a fall in the temperature of the extremity, an injection of dye, or nail polish. The EKG can note tachycardia, but this may be due to pain, inadequate anesthesia, hypovolemia, or a medication we have just injected. Likewise, a fall in the heart rate can have as many causes. The blood pressure might be reduced with hypovolemia, tachycardia/bradycardia, decrease in venous return, or a relative overdose of an anesthetic. The pulmonary capillary wedge pressure (PCWP) might decrease with a fall in volume or because the cardiac output has increased. An increased PCWP could indicate a change in volume status or impending cardiac failure. Urine output may depend on volume status, previous diuretic therapy, cardiac output, or blood pressure.

None of these are really specific. Clinicians use their experience and assessment of all the variables before deciding on the cause of an alteration in their patient's condition. Only then can the appropriate response be determined and carried out. The use of mixed venous saturation monitoring can provide the clinician with another source of information to facilitate proper management. Evaluation of a change in saturation is similar to the assessment given to changes noted on other monitors.

Other possible monitors such as a pulmonary artery catheter with continuous cardiac output capability or transesophageal echocardiography were not available at the times of these patient's surgeries.

Anesthetic management of patients with severe peripheral vascular disease is always a challenge. Extensive surgery and the potential blood losses, in addition to the patients' underlying condition makes continuous monitoring of hemodynamics mandatory. However, our usual sites for vascular access may not be available. Measurement of urine output as a marker of adequacy of perfusion and volume status may also not be possible. These two cases showed the efficacy of an oximetric pulmonary artery catheter as a continuous intraoperative monitor. The use of an oximetric PAC should be considered in those intraoperative situations when the continuous monitoring of a patient's oxygen delivery status is required.

References

1. Lugo G, Arizpe D, Dominguez G, Ramirez M, Tamariz O: Relationship between oxygen consumption and oxygen delivery during anesthesia in high-risk surgical patients. Crit Care Med 21:64-69, 1993.
2. Powelson JA, Maini BS, Bishop RL, Sottile FD: Continuous monitoring of mixed venous saturation during aortic operations. Crit Care Med 20-332-336, 1992.
3. Vedrinne C, Bastien O, De Varax R, Blanc P et al.: Predictive factors for usefulness of fiberoptic pulmonary artery catheter for continuous oxygen saturation in mixed venous blood monitoring in cardiac surgery. Anesth Analg 85:2-10, 1997.
4. Birman H, Haq A, Hew E, Aberman A: Continuous monitoring of mixed venous oxygen saturation in hemodynamically unstable patients. Chest 86:753-756, 1984.
5. Cariou A, Monchi M, Dhainaut JF. Continuous cardiac output and mixed venous saturation monitoring. J Crit Care 13:198-213, 1997.
6. Baele PL, McMichan JC, Marsh HM, Sil JC, Southorn PA: Continuous mixed venous oxygen saturation in critically ill patients. Anesth Analg 61:513-7, 1982.
7. Nelson LD: Continuous venous oximetry in surgical patients. Ann Surg 203:329-33, 1986.
8. Norfleet EA, Watson CB: Continuous mixed venous oxygen saturation measurement: A significant advance in hemodynamic monitoring? J Clin Monit 1:245-58, 1985.

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