Overestimation of Cardiac Output by Bent Pulmonary Artery Catheter

Sir,

A 56-year-old male presented with chest pain on mild exertion for 2 days. His electrocardiogram was suggestive of anterior wall ST-elevation myocardial infarction. Coronary angiography revealed three vessels coronary artery disease. Patient was scheduled for coronary artery bypass grafting surgery. Preoperative transthoracic echocardiography was performed, and it showed left ventricular ejection fraction 40% with hypokinetic anterior wall. There was no tricuspid regurgitation or any intracardiac shunt. Echocardiographically calculated cardiac index was 2 L/min/m^2. Anesthesia was induced without any incident. Patient was hemodynamically stable with heart rate of 84/min and systemic blood pressure 110/64 mmHg. Considering left ventricular dysfunction, Swan-Ganz catheter was inserted through right internal jugular vein for hemodynamic monitoring. Pulmonary artery (PA) catheter displayed PA waveform at 40 cm. To obtain wedge waveform, it was further advanced till the distance of 45 cm. However, appearance of ventricular ectopic while advancing stopped us from further progression. PA pressure was 42/20 mmHg, and PA wedge pressure was assumed to be 18–20 mmHg equivalent to PA diastolic pressure in the absence of any mitral valve pathology and lung disease. For hemodynamic parameters estimation, Swan-Ganz catheter was attached to calibrated continuous cardiac output (CO) monitor (Vigilance). The monitor displayed cardiac index 3.4 L/min/m^2 even before starting off-pump coronary bypass grafting without any inotropic support. Cardiac index remained in the range of 3.2–3.6 L/min/m^2 throughout the surgery confirmed by intermittent bolus thermodilution technique also. Patient's temperature was in the range of 35.8°C–36.7°C. Postoperatively, transthoracic echocardiography revealed cardiac index in the range of 2.2–2.5 L/min/m^2 whereas continuous CO still showed cardiac index around 3.5 L/min/m^2. There was the difference in CO measurements by two different methods. Postoperative chest x-ray showed bent in distal PA catheter [Figure 1]. Apart from PA catheter derived CO, other hemodynamic variables such as mean arterial pressure, central venous pressure, heart rate, rhythm, lactate, and urine output were also monitored. Overall erroneous CO readings did not affect the management of the patient.

Thermodilution technique has been used as a standard method of measuring CO.[1] In clinical practice, thermodilution method in PA catheter is used by giving cold saline bolus

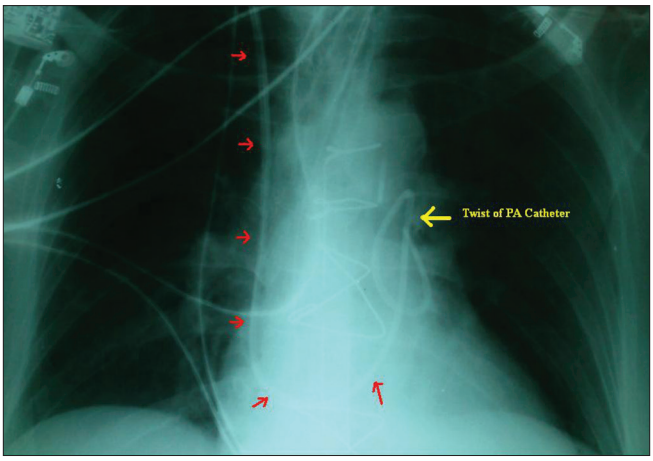

Figure 1: Postoperative chest X-ray showing course of pulmonary artery catheter

or using continuous automated CO monitor using Heater Wire in PA catheter. Continuous thermodilution CO catheter has thermal filament (10 cm length). Distal end of thermal segment is at distance of 13.5 cm from tip of the catheter. This filament is intermittently heated to about 44°C. Change in temperature of blood is noted by thermistor at the tip, and thermodilution curve of change in temperature against the time is plotted to determine COcardiac output by using a modified Stewart Hamilton equation. There are well -known fallacies in deriving CO cardiac output by thermodilution principles. Tricuspid regurgitation, intracardiac shunt, fluid infusion through proximal part of the catheter, and variations in basal PA temperature can cause over- or underestimation of CO. However, the present patient did not have any of such conditions. Continuous CO (CCO) is associated with lower incidences of overestimation than the bolus method.[1] Interindividual variation in infusing the tracer bolus (speed and volume) is avoided during CCO determination.[2] CCO reading is an average of measurements made over a period of time. Hence, increasing the integration period of the signal can potentially reduce the influence of factors limiting thermodilution technique-derived CO.[3]

In the present case, distal portion of PA catheter is bent in PA. This brings distally placed thermistor near the thermal filament [Figure 2]. Transit time for warm blood to reach thermistor becomes less as compared to the PA catheter with straight course, causing overestimation of CO value.[4] Even though intraoperative transesophageal echocardiography was not performed in the current case, it would have been helpful in such cases to see the course of PA catheter along with calculating CO.

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Nil.

Conflicts of interest

There are no conflicts of interest

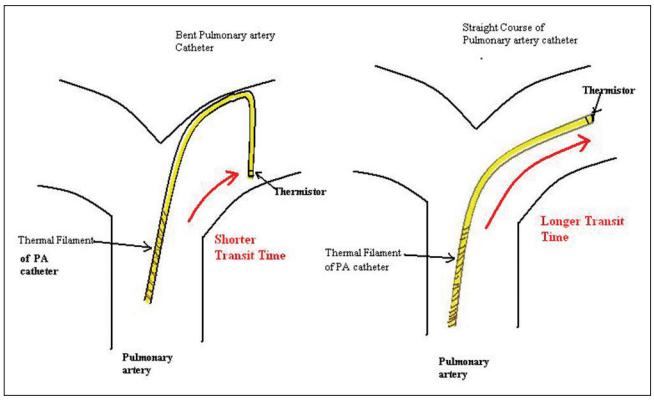

Figure 2: Schematic diagram explaining the mechanism of high cardiac output shown by bent pulmonary artery catheter

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