

MEASUREMENT OF CARDIAC OUTPUT IN VENTRICULAR RUPTURE FOLLOWING ACUTE MYOCARDIAL INFARCTION

- Pulmonary Artery Catheter vs Transpulmonary Thermodilution - - A Case Report -

SCHWARZKOPF KONRAD*, SIMON STEFAN,
PREUSSLER NIELS-PETER AND HÜTER LARS

Abstract

We compared the cardiac output measured by the transpulmonary aortic single indicator thermodilution method with that by the pulmonary artery catheterization in a patient with ventricular septal rupture after acute myocardial infarction. Though the former cardiac output was lower than the latter, in the presence of the ventricular septal rupture, the cardiac outputs were equal after the rupture was closed. This indicates that, while the cardiac output measured by the pulmonary artery catheter is influenced by the ventricular left-to-right shunt, transpulmonary aortic thermodilution method measures the true cardiac output of the left heart, which is responsible for organ perfusion.

Keywords: Hemodynamic monitoring, pulmonary artery catheter, transpulmonary aortic single indicator thermodilution method, ventricular septal rupture.

Introduction

Ventricular septal rupture complicating an acute myocardial infarction has a high mortality rate up to 90% in medically treated patients¹. Pulmonary arterial catheterization (PAC) is often used for hemodynamic monitoring of these patients during transportation to a specialized hospital for definitive surgical intervention²⁻⁴. A major problem with the PAC in the presence of a ventricular septal defect is that PAC may overestimate the cardiac output in this situation, because the measured value contains the left-to-right shunt and the true cardiac output of the left ventricle.

The transpulmonary single indicator thermodilution method (TTM) is a less invasive method to measure the cardiac output compared with PAC.

Following an injection of the cold saline into the venous part of the circulation (e.g. via the internal jugular vein) the resulting change in temperature is measured with a thermodilution catheter typically located in the femoral artery. The cardiac output is calculated based on the Stewart-Hamilton equation. An intracardial left-to-right shunt does not disturb the cardiac output measurements using TTM.

We present the case of a patient with ventricular septal rupture where the cardiac outputs derived from PAC and TTM were compared.

From Department of Anesthesiology and Intensive Care Therapy, Friedrich-Schiller-University, Jena, Germany.

* Corresponding author: Dr. Konrad Schwarzkopf, Klinik fuer Anaesthesiologie und Intensivtherapie, Klinikum der Friedrich-Schiller-Universitaet, Erlanger Allee 101, 07740 Jena, Germany. Phone: 0049-(0)3641-9323279, Fax: 0049-(0)3641-9323112, E-mail: konrad.schwarzkopf@med.uni-jena.de

Case Report

A 67-year-old man was admitted to the hospital with epigastric pain for 3 days. On admission, the troponin I level was 22,7 ng/ml and the ECG showed an inferior myocardial infarction. After establishment of mechanical support with an intraaortic balloon pump to treat acute hemodynamic deterioration, coronary angiography, echocardiography and right heart catheterization confirmed the diagnosis of a ventricular septal rupture. The oxygen saturation increased from the right atrium (40%) to the right ventricle (96%).

Before surgery was started, a femoral arterial thermodilution catheter (PV 2015 L 20, Pulsion Medical Systems, Munich, Germany) was inserted in the right femoral artery and connected to a monitor for transpulmonary aortic thermodilution measurement of cardiac output (PiCCO V4.1, Pulsion Medical Systems, Munich, Germany). A 7-French pulmonary artery catheter (Baxter, Irvine, USA) was inserted via the right internal jugular vein and connected to a hemodynamic monitor (Vigilance Monitor, Baxter, Irvine, USA).

Cardiac output measurements were performed in triplicate with 15 ml cold saline (1-5°C) injected through the central venous catheter and averaged. The PAC measured a cardiac output of the right heart of 12.9 l/min, whereas TTM showed a cardiac output of the total heart of 2.95 l/min. Measured by the PAC mixed venous saturation was 86%, mean pulmonary artery pressure was 34 mmHg, pulmonary wedge pressure was 24 mmHg, the central venous pressure was 19 mmHg.

After surgical patch closure of the septal rupture another set of cardiac output measurements by three bolus injections was done. Cardiac output measured by PAC was 6.9 l/min compared with 6.8 l/min cardiac output by TTM. The patient died postoperatively due to multisystem organ failure. The sufficient patch closure was verified on autopsy.

References

1. BIRNBAUM Y, FISHBEIN MC, BLANCHE C, SIEGEL RJ: Ventricular septal rupture after acute myocardial infarction. *N Engl J Med*; 2002, 347:1426-32.
2. FUCHS RM, HEUSER RR, YIN FC, BRINKER JA: Limitations of pulmonary V waves in diagnosing mitral regurgitation. *Am J Cardiol*; 1982, 49:849-54.
3. KONSTANTINIDES S, GEIBEL A, KASPER W, JUST H: Noninvasive estimation of right ventricular systolic pressure in postinfarction ventricular septal rupture. An assessment of two Doppler

Discussion

This case demonstrates that TTM could provide more accurate hemodynamic monitoring in patients with ventricular septal rupture. Transpulmonary aortic thermodilution measurement of cardiac output is done between the injection port of the central venous catheter positioned in the V cava superior/right atrial junction and the tip of the arterial catheter positioned via the femoral artery in the abdominal aorta. Intracardiac left-to-right shunt does not affect this method of measurement. In contrast, the cardiac output of the left heart, which is responsible for the organ perfusion via the aorta, could not be measured by the PAC in the presence of the ventricular septal rupture. In this situation the PAC provided right heart cardiac output, which was increased by the interventricular left-to-right shunt.

The use of PAC for measurement of cardiac output has also a limitation in patients with other causes of a left-to-right-shunt. Breukers et al. measured cardiac output with PAC and TTM in a patient with a partial anomalous pulmonary vein, revealing clinically significant difference in the cardiac output values⁵.

Monitoring of cardiac output in patients with a ventricular septal rupture is important to control medical therapy until the time for cardiac surgery. This case suggests that the PAC may provide misleading information. The evaluation of volume responsiveness by measurement of right heart cardiac output in the presence of a left-to-right-shunt for example is insufficient. Also mixed venous saturation or derived data such as systemic vascular resistance are not useful in this situation, because these data are influenced by the left-to-right-shunt. Therefore, TTM may be more useful in monitoring the cardiac output in these patients.

4. echocardiographic methods. *Crit Care Med*; 1997, 25:1167-74.
4. TOPAZ O, TAYLOR AL: Interventricular septal rupture complicating acute myocardial infarction: from pathophysiologic features to the role of invasive and noninvasive diagnostic modalities in current management. *Am J Med*; 1992, 93:683-8.
5. BREUKERS RBGE, JANSEN JRC: Pulmonary artery thermodilution cardiac output vs. transpulmonary thermodilution cardiac output in two patients with intrathoracic pathology. *Acta Anaesthesiol Scand*; 2004, 48:658-61.