PAROXYSMAL ATRIAL TACHYCARDIA ASSOCIATED WITH CARDIogenic SHOCK DURING WATER INJECTION FOR TRANSPULMONARY THERmodilution OF HEMODYNAMIC MONITOR

Chih-Dou Chou

Abstract

The pulmonary arterial (PA) catheter is widely used for the hemodynamic monitoring and the related complications are well recognized. The PiCCO® monitoring system (Pulsion Medical Systems, Munich, Germany) provides hemodynamic evaluation by similar techniques. The volume of injectate for thermodilution is 15 ml for PiCCO® monitoring system instead of 5 ml for pulmonary artery catheter. There has yet no complications related to water injection during thermodilution measurement reported. We reported a rare complication of paroxysmal atrial tachycardia (PAT) associated with cardiogenic shock by water injection through central venous catheter during measurement of transpulmonary thermodilution.

Key Words: Thermodilution; Paroxysmal atrial tachycardia; Cardiogenic shock

Introduction

The PiCCO® monitoring system (Pulsion Medical Systems, Munich, Germany) provides hemodynamic evaluation and monitoring by transpulmonary thermodilution (TPD) and arterial pulse contour analysis. It combines a regular central venous catheter (CVC) and a Pulsiocath in the femoral or radial artery. Its principle is similar to that of Swan-Ganz catheter. The temperature sensor is incorporated at femoral or radial arterial catheter (Pulsiocath). The cold water injected site is through regular central venous catheter distal port instead of a specialized port of pulmonary artery catheter. The volume of injectate for thermodilution is 15 ml for PiCCO® monitoring system instead of 5 ml for pulmonary artery catheter.

Major complications related to Pulsiocath including thrombosis, peripheral necrosis, general infection, obstruction, temporary ischemia or edema and local infection.\(^1\) Complications related to central venous catheter and pulmonary arterial catheter occur mostly during procedure of insertion includes arterial puncture, improper position, pneumothorax, pulmonary embolism, air embolism, dysrhythmia.\(^{2-4}\) Severe arrhythmia has been reported at insertion but has not yet reported during cold water injection for thermodilution measurement.

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We reported a complication of paroxysmal atrial tachycardia (PAT) associated with cardiogenic shock by water injection through central venous catheter during measurement of transpulmonary thermodilution.

**Case Presentation**

A 92-year-old Asia man with a history of congestive heart failure (New York Heart Association class II) was hospitalized because of progressively jaundice and general malaise. He received Whipple’s procedures for a pancreatic head tumor diagnosed by an abdominal computer tomography. After the operation was concluded, the patient was sent to surgical intensive care unit (SICU) for postoperative care. There were about 500 ml fresh blood from Jackson-Pratt drain in first fours hours of post-operative period. The bleeding did not cease despite fresh frozen blood and pack red cell transfusion. Therefore, the surgeon performed exploratory laparotomy to check bleeding. Neither significant anastomosis leak nor vascular tear was noted during the procedure. Acute deteriorated oxygenation was noted after returning to SICU. Chest x-ray revealed bilateral diffuse infiltrate over both lung fields consistent with acute respiratory distress syndrome. Hence, the PiCCO® system was inserted for accurate cardio-pulmonary performance monitor. Hemodynamic parameter was measured by rapid injection of 15 ml 4°C cold water 3 times through the distal port of central venous catheter (ARROW®, Two-lumen Central Venous Catheter) in 8 hours interval. This CVC was inserted during the Whipple’s procedure without any complications and the location of CVC was confirmed by chest x-ray film at the junction of superior venous cava and right atrium. All hemodynamic parameter were collected with an average of 3 sequential measurements. Patient was heavily sedated with continuous intravenous infusion of midazolam and morphine to the Ramson’s sedative score of 3 to 4 level.

The first 3 series of thermodilution measurements were undergone uneventfully. There is an abrupt onset of paroxysmal atrial tachycardia during the fourth thermodilution measurement. Mean arterial pressure dropped to less than 60 mmHg consistent with cardiogenic shock. The PAT persisted for about 3 hours despite initial intravenous infusion of adenosine and verapamil. The rhythm then spontaneously reverted to baseline rhythm. Our first impression was that the PAT was triggered by 4°C cold saline injection. Therefore, room temperature (25°C) saline was used for subsequent thermodilution measurements. Unfortunately, another episode of PAT with poor response to intravenous infusion of adenosine and verapamil occurred immediately following room temperature (25°C) saline injection. Although, the second PAT was shorter in duration and less severe than that of first one.

The TPD hemodynamic measurement was terminated because of this life-threatening complication. A cardiac sonography was performed and series of cardiac enzymes were collected to determine if there was any permanent cardiac damage. The cardiac sonography showed no significant structural or functional deterioration compared to the first cardiac sonography done before operation. Two series of cardiac enzymes showed no evidence of cardiac injury (Table 1). The serial hemodynamic profiles measured by transpulmonary thermodilution technique were also shown (Table 2).

The patient stayed in SICU for a total of forty two days due to repeated sepsis and acute respiratory distress syndrome. He was discharged from hospital in a stable condition after additional twenty seven days of rehabilitation.

<p>| Table 1. Serial cardiac enzyme of the patient |</p>
<table>
<thead>
<tr>
<th>Day1</th>
<th>Day2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK-MB</td>
<td>2</td>
</tr>
<tr>
<td>CPK</td>
<td>92</td>
</tr>
<tr>
<td>Troponin I</td>
<td>0.82</td>
</tr>
</tbody>
</table>
The pulmonary arterial (PA) catheter is widely used for hemodynamic monitoring in critically ill patients for several decades and the related complications are well recognized. There has yet no complications related to water injection during thermodilution measurement reported. The technique for TPD measurement by central venous catheter is similar to that by PA catheter except for the volume recommended at rapid injection (15 ml for CVC compared to 5 ml for PA catheter). Therefore, the pressure through the port applied to the junction of superior venous cava and right atrium is theoretically increased. This increased mechanical pressure may trigger the sinus atrial node to induce PAT. The effect of temperature may also play a role in triggering PAT since the second PAT episode was less severe and shorter with 25°C saline injection than that with 4°C saline.

Despite the fact that the TPD measurement by CVC seems to encounter less technical problems during insertion and cause fewer complications in general than that by PA catheter. The potential side effect caused by rapid cold water injection warrants special precaution, especially for those who have an underlying heart disease or are elderly with a critical illness.

### Discussion

The pulmonary arterial (PA) catheter is widely used for the hemodynamic monitoring in critically ill patients for several decades and the related complications are well recognized. There has yet no complications related to water injection during thermodilution measurement reported. The technique for TPD measurement by central venous catheter is similar to that by PA catheter except for the volume recommended at rapid injection (15 ml for CVC compared to 5 ml for PA catheter). Therefore, the pressure through the port applied to the junction of superior venous cava and right atrium is theoretically increased. This increased mechanical pressure may trigger the sinus atrial node to induce PAT. The effect of temperature may also play a role in triggering PAT since the second PAT episode was less severe and shorter with 25°C saline injection than that with 4°C saline.

Despite the fact that the TPD measurement by CVC seems to encounter less technical problems during insertion and cause fewer complications in general than that by PA catheter. The potential side effect caused by rapid cold water injection warrants special precaution, especially for those who have an underlying heart disease or are elderly with a critical illness.

### References


| Table 2. Hemodynamic data from transpulmonary thermodilution monitor |
|------------------------|----------------|-----|-----|-----|-----|-----|-----|
|                       | CI  | MAP | HR  | CVP | SVI | GEDI | ITBI | ELWI |
| Before PAT            | 2.37| 75  | 83  | 12  | 27  | 753  | 941  | 18   |
| 1\textsuperscript{st} PAT episode | 2.14| 48  | 187 | 9   | 16  | 711  | 888  | 20   |
| 2\textsuperscript{nd} PAT episode | 2.46| 54  | 136 | 7   | 23  | 751  | 779  | 21   |

CI: Cardiac Index  
MAP: Mean arterial pressure  
HR: Heart rate  
CVP: Central venous pressure  
SVI: Stroke volume index  
GEDI: Global end diastolic index  
ITBI: Intrathoracic blood index  
ELWI: Extra-lung water index
PiCCO熱稀稀注射引起心律不整的心因性休克

周志道

摘要

肺動脈導管已廣泛使用於偵測血流動態參數來評估病人的輸液治療，其相關併發症已有許多報告討論。新一代的血流動態監視器PiCCO利用類似的熱稀釋原理，經由中央靜脈導管遠端注入15毫升的冷水。我們報告一個手術後發生成人呼吸窘迫症的病人，在使用PiCCO熱稀釋器注入冷水15毫升的瞬間產生嚴重偶發性心房心搏過速而導致心因性休克的病例。

關鍵詞：熱稀釋，偶發性心房心搏過速，心因性休克

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