



# Ventricular fibrillation during pulmonary artery catheter placement in a patient with Stanford type A aortic dissection: a case report

Tsukasa Kochiyama<sup>^</sup>, Yukari Kusano, Ai Yamaguchi, Shona Sakuraya, Izumi Kawagoe

Department of Anesthesiology and Pain Medicine, Juntendo University School of Medicine, Tokyo, Japan

*Contributions:* (I) Conception and design: T Kochiyama, A Yamaguchi; (II) Administrative support: Y Kusano, S Sakuraya; (III) Provision of study materials: T Kochiyama, A Yamaguchi; (IV) Collection and assembly of data: Y Kusano, S Sakuraya; (V) Data analysis and interpretation: T Kochiyama, I Kawagoe; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Izumi Kawagoe. Department of Anesthesiology and Pain Medicine, Juntendo University School of Medicine, 2-1-1 Hongo, Bunkyo-ku, Tokyo 113-8421, Japan. Email: ikawago@juntendo.ac.jp.

**Background:** Stanford type A acute aortic dissection is a severe and fatal cardiovascular emergency condition. In cases where the intimal flap occludes a coronary artery, myocardial ischemia can occur and induce lethal arrhythmias. A pulmonary artery catheter (PAC) is an effective monitor in cardiac patients. However, the indications for pulmonary artery catheterization remain controversial due to associated complications including fatal arrhythmia. Herein, we report a case of a patient with Stanford type A acute aortic dissection, who experienced serious ventricular fibrillation (VF) during PAC insertion.

**Case Description:** A 48-year-old man underwent ascending aortic arch replacement for Stanford type A acute aortic dissection with entry into the ascending aorta. His electrocardiogram showed ST-segment elevation from V1 to V4, and suspected myocardial ischemia. A PAC was placed under transesophageal echocardiography (TEE) guidance. Fourth attempts were required before the catheter was advanced with difficulty. Premature ventricular contractions (PVCs) appeared upon reaching the right atrium, thus resulting in severe hypotension and subsequent VF. After chest compressions, electrical defibrillation, and administration of lidocaine and nifekalant, sinus rhythms returned after the fourth defibrillation. After resuscitation, the surgery was completed without any problems.

**Conclusions:** Pulmonary artery catheterization should be carefully indicated in cases with restricted coronary perfusion, enlarged ascending aorta, and normal left ventricular function because of the potential risk for fatal arrhythmias.

**Keywords:** Pulmonary artery catheter (PAC); ventricular fibrillation (VF); critical care after fatal arrhythmia; case report

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## Introduction

### Background

The continuous monitoring of hemodynamics is crucial for maintaining adequate tissue perfusion and oxygen levels in patients with severe cardiac disease. A pulmonary artery

catheter (PAC) can continuously measure hemodynamic variables such as pulmonary artery pressure, pulmonary artery wedge pressure, central venous pressure, cardiac output, and mixed venous oxygen saturation (SvO<sub>2</sub>). Therefore, the PAC is an effective monitor in cardiac patients. However, the use of PAC can possibly cause severe

<sup>^</sup> ORCID: 0000-0001-9768-7942.

to fatal complications as previously reported (1). Similarly, we experienced fatal arrhythmia during PAC insertion. Therefore, its routine use in cardiac surgery remains controversial due to the complications associated with the invasive procedure.

### *Rationale and knowledge gap*

Surveys have reported that about one-third of respondents routinely use PACs in all cases of cardiopulmonary bypass (CPB) surgery (2). In fact, in our hospital, we routinely use PACs in all cardiac surgery cases. Presently, there are no comprehensive guidelines outlining the indication criteria for the use of PAC in cardiac surgery. The use of PAC should be indicated based on patient risk, surgical procedure, and clinical circumstances.

The supervision of a specialist and use of an ultrasound guide is recommended and necessary for the safe insertion of the central venous line and placement of PAC (3).

### *Objective*

We report an incidence of ventricular fibrillation (VF) occurring during catheter insertion, despite the utilization of an ultrasound guide, in a patient with Stanford type A acute aortic dissection. We discuss the risks of routine

PAC use in patients with normal left ventricular function, an enlarged ascending aorta, and suspected myocardial ischemia. The case was prepared according to the CARE reporting checklist (available at <https://amj.amegroups.com/article/view/10.21037/amj-22-89/rc>).

### **Case presentation**

A 48-year-old man (height, 171 cm; weight, 75 kg) with severe untreated hypertension was admitted for emergency complaints of chest pain and ST-segment elevation from V1 to V4 on electrocardiogram, and was suspected for acute myocardial infarction on December 1<sup>st</sup>, 2020. Angiography revealed a Stanford type A acute aortic dissection with entry into the ascending aorta, and the patient underwent emergency surgery on the same day. Preoperative transthoracic echocardiography showed good left ventricular wall motion without any valvular disorder. The dissected lumen extended to the aortic root. Contrast-enhanced computed tomography (CT) revealed that the aortic root was enlarged to 45 mm (*Figure 1*). Hematological examination revealed no abnormalities.

General anesthesia was induced and maintained with propofol, sevoflurane fentanyl, and rocuronium. Tracheal intubation was performed after muscle reluctance was achieved. Transesophageal echocardiography (TEE) was performed after tracheal intubation. Regional oxygen saturation (rSO<sub>2</sub>) and bispectral index (BIS) monitoring was performed on both sides of the forehead. An arterial catheter was placed in both radial arteries to measure blood pressure. A central venous catheter and a PAC were placed in the right internal jugular vein. We attempted to insert the PAC under TEE guidance, but it was difficult to reach the right ventricle. After the catheter was repeatedly withdrawn and inserted, it reached the right atrium at the fourth insertion. However, premature ventricular contractions (PVCs) occurred, thus resulting in hypotension, which then shifted to VF (*Figure 2*). We immediately initiated chest compressions and electrical defibrillation (biphasic 150 J) and administered 100 mg of lidocaine and 20 mg of nifekalant. Sinus rhythm returned after the fourth electrical defibrillation. Electrolyte abnormalities were ruled out on the basis of the results of blood gas tests. The duration of PAC placement time was 7 min, and the duration of VF was 2 min 30 s. We stopped advancing the PAC into the pulmonary artery and initiated the surgery. Intraoperative TEE revealed that the dissected lumen extended to the aortic root. The intimal flap covered the origin of the

#### **Highlight box**

##### **Key findings**

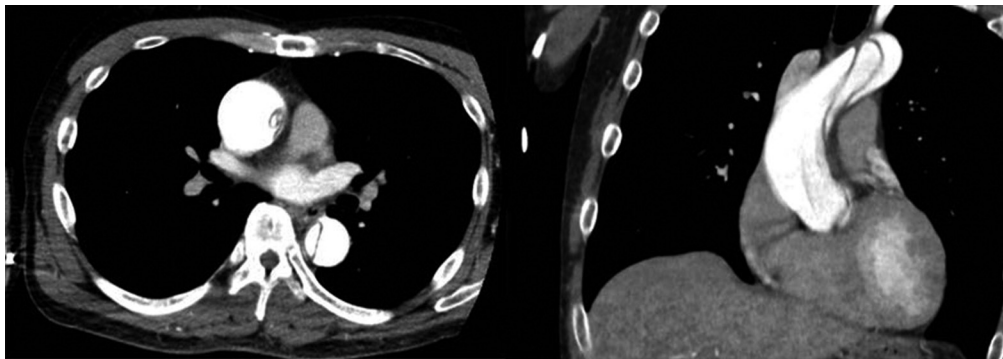
- We encountered a case of ventricular fibrillation (VF) during pulmonary artery catheter (PAC) placement in a patient with a Stanford type A aortic dissection. The patient was treated appropriately. However, it is unclear whether PAC insertion was appropriate for this case.

##### **What is known and what is new?**

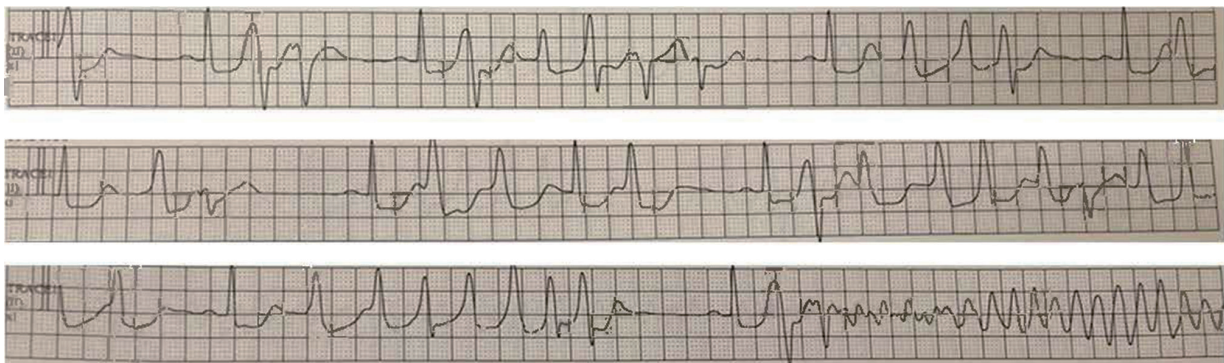
- The indications for pulmonary artery catheterization are controversial and the routine use of a PAC is not recommended because of the complications associated with this invasive procedure.
- The placement of a PAC in patients with an enlarged ascending aorta is very difficult. VF is more likely to occur in cases of suspected myocardial ischemia.

##### **What is the implication, and what should change now?**

- The indications for pulmonary artery catheterization in patients with an enlarged ascending aorta and suspected myocardial ischemia should be carefully considered. Furthermore, the use of PACs should be avoided in these cases.



**Figure 1** Contrast-enhanced thoracic CT scan images. The collapsed true and false lumens were contrasted and indicated Stanford type A aortic dissection. Dissection in the ascending aorta showed a false lumen communicating with the true lumen. CT, computed tomography.



**Figure 2** Electrocardiogram lead II. Several premature ventricular contractions appeared, which was followed by the occurrence of ventricular fibrillation.

left coronary artery, thus resulting in reduced coronary perfusion (*Figure 3*).

Ascending aortic arch replacement was successfully completed, and the PAC was placed in the pulmonary artery under TEE guidance after CPB. The CPB time was 216 min, operation time was 453 min, and anesthesia time was 488 min. Intraoperative BIS monitoring and  $rSO_2$  measurement showed normal values.

The patient was transferred to the intensive care unit (ICU) postoperatively. Nicardipine was continuously administered as an intravenous infusion of 1 to 3 mg/h to maintain systolic blood pressure of <110 mmHg until discharge from the ICU. Amiodarone (600 mg/day) and landiolol (1–3  $\mu$ g/kg/min) were administered to prevent VF recurrence until postoperative day (POD) 1. The patient was extubated on POD 1 and discharged from the ICU on POD 3. No fatal arrhythmias occurred during

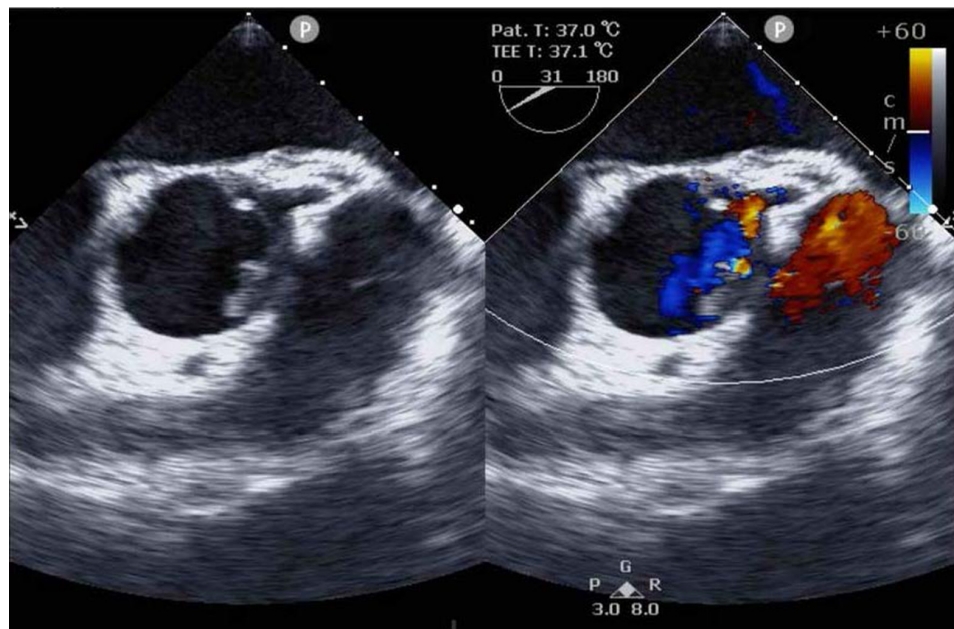
the study period. The patient was discharged without any neurological symptoms or other complications on POD 15.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

## Discussion

### Key findings

Various complications associated with PAC placement have been reported including infection, adjacent aortic injury, pulmonary artery injury, pulmonary emboli, heart valve injury, and arrhythmia (4). Arrhythmias related to PAC



**Figure 3** Transesophageal echocardiography: aortic valve short axis view. A dissected intimal flap was also observed. The left coronary artery showed blood flow from the true lumen; however, the flap could have limited coronary perfusion.

originate from ectopic atrial and ventricular beats, atrial and ventricular tachycardias, and conduction abnormalities. The incidence of arrhythmias during PAC placement has been reported to range from 12.5% to 70%. PVCs are the most common arrhythmias (52–68%), followed by non-sustained ventricular tachycardias. Even though ventricular tachycardia and fibrillation are rare (occurring in less than 1% of cases), they are always fatal once they occur (5,6). In cases involving cardiogenic shock and severe cases, PAC does not confer significant benefits with respect to reduced mortality, shorter ICU stays and hospitalization times, and lower medical costs in the ICU (7,8). A meta-analysis of 13 randomized clinical trials found that the insertion of a PAC in critically ill patients had no benefits or disadvantages (9). Meanwhile, various complications are associated with PAC insertion, and the benefits of this procedure are unclear. Therefore, the indications for PAC insertion remain controversial.

In our case, PAC insertion was difficult to advance the catheter into the right ventricle and PAC placement time was increased. During withdrawal and insertion of the catheter, VF occurred. In the case of Stanford type A aortic dissection with coronary artery blood flow restriction due to arterial intimal flap obstruction, VF occurred following an arrhythmia due to PAC insertion. In cases with normal left

ventricular function, PAC should be avoided because the benefits of PAC are unclear.

### *Strengths and limitations*

This case report's strength is that it describes a rare but fatal complication of PAC insertion in an aortic dissection case. We suggested a reconsideration of the routine use of PAC and administered antiarrhythmics, vasodilators, and beta-blocker to maintain good hemodynamic status without VF recurrence in the ICU. However, this case report also has a limitation. The other causes of VF should be acknowledged including low coronary perfusion pressure, arrhythmia, and hypotension on top of other contributing factors

### *Comparison with similar researches*

PAC can continuously measure hemodynamic parameters. These parameters can clarify the reasons for the intervention and its effectiveness. Some studies have suggested that a PAC is useful for postoperative management of cardiac surgery in the ICU (10).

The reported complications of PACs can be categorized into four groups: central venous access, complications related to catheter procedures, complications associated

with the long-term presence of the catheter, and errors resulting from incorrect interpretation of PAC-derived data. Sangkum *et al.* summarized various complications in the manuscript (11). For central venous puncture, Seldinger's technique using a guidewire with ultrasound is safer and less risky for unintentional punctures (4). The advancement of a PAC under TEE guidance is also safer than conventional methods of checking the pressure waveform (12); this is why TEE insertion is preferable before PAC insertion. Catheterization may occasionally cause a right bundle branch block. Patients with a preoperative left bundle branch block require more attention because they may develop a complete atrioventricular block, thus necessitating pacemaker treatment (13).

In our case, VF was treated with immediate chest compressions, electrical cardioversion, and antiarrhythmics. Lidocaine, nifekalant, and amiodarone are the typical antiarrhythmic agents used for VF. Lidocaine is associated with lower survival during hospitalization than amiodarone, but the two agents show no significant difference in relation to survival and discharge (14). Nifekalant is reportedly more effective for defibrillation than lidocaine. Nifekalant is a pure delayed rectifier potassium channel blocker that prolongs the refractory period. Its major advantage is that it has little effect on sodium or calcium channels; therefore, it has no negative inotropic or vasodilating effects (15). Nifekalant and amiodarone improved 24-h survival to a similar degree in a multicenter cohort study. The time from drug administration to successful defibrillation was significantly shorter with nifekalant than with amiodarone (16). The effects of nifekalant and amiodarone in a porcine model of 4-min cardiac arrest due to VF were investigated in one study, which showed that the return of spontaneous circulation (ROSC) and 24 h survival rates were not different between the two groups, but the coronary perfusion pressure at 30 min after ROSC was significantly higher with nifekalant than with amiodarone. The difference in coronary perfusion pressure immediately after resuscitation may have affected the time to ROSC (17). In our case, nifekalant administration contributed to the return to sinus rhythm.

In intensive care management, the control of blood pressure and the prevention of arrhythmia recurrence are important for maintaining organ blood perfusion in patients after aortic dissection surgery and VF resuscitation. Our patient received continuous amiodarone, landiolol, and electrolyte management to prevent VF recurrence.

Amiodarone administration is considered useful for survival according to the 2015 American Heart Association guidelines (14). However, it failed to achieve better survival to discharge and neurological outcomes compared with placebo in a randomized controlled trial in 2016 (18). Serum potassium levels during the first 72 h of treatment and the use of beta-blocking agents were significantly associated with survival from out-of-hospital cardiac arrest (19). Beta-blocker administration during cardiac surgery reduces the incidence of atrial fibrillation and ventricular arrhythmias (20). In our case, the patient maintained good hemodynamic status without VF recurrence owing to the administration of amiodarone and beta-blockers in the ICU.

### *Explanations of findings*

In our case, PAC insertion was attempted under TEE guidance, but it was difficult to advance the catheter into the right ventricle probably because of the right atrial compression of the enlarged aortic root. VF consequently occurred during the repeated withdrawal and insertion of the catheter. Electrocardiography revealed that the ST segment was elevated in V1–V4, and coronary artery occlusion due to the arterial intimal flap may have been restricted to the coronary artery blood flow. VF may occur because of the hypotension induced by anesthetic induction and by the mechanical stimulation of the myocardium by the PAC, which results in extrasystole and exacerbation of myocardial ischemia. The enlargement of the proximal ascending aorta may compress the right atrium and right ventricle. A longer PAC insertion time leads to a higher incidence of ventricular arrhythmia (21).

### *Implications and actions needed*

In our case, the enlargement of the proximal ascending aorta can provide more challenge to PAC insertion. Longer insertion time leads to a higher incidence of ventricular arrhythmia (21). The arterial intimal flap in the aortic root can obstruct the coronary artery. Mechanical stimulation to the myocardium by the PAC can cause extrasystole, hypotension, and exacerbation of myocardial ischemia, resulting in VF. In an enlarged ascending aorta with normal left ventricular function, PAC should be avoided to prevent fatal arrhythmias. Even if PAC is used, it is best to stop in the right atrium until surgical repair and advance it into the pulmonary artery only after the surgical repair.

## Conclusions

In conclusion, we observed VF during PAC placement in a patient with a Stanford type A aortic dissection. VF was treated appropriately, and the surgery was successfully completed. Postoperative antiarrhythmic care ensured a stable hemodynamic status. We should not use a PAC in patients with an enlarged ascending aorta and suspected myocardial ischemia.

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## Footnote

*Reporting Checklist:* The authors have completed the CARE reporting checklist. Available at <https://amj.amegroups.com/article/view/10.21037/amj-22-89/rc>

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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