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Retrograde Type a Aortic Dissection During Femoral Artery Cannulation

Jinyoung Kim[1], Sohyun Kim[1], Gwanguk Kim[1], Songhyun Kim[1], Ilseok Kim[1*]

[1]Department of Anesthesiology and Pain Medicine, Kangdong Sacred Heart Hospital, 150 Seongan-ro, Gangdong-gu, Seoul 05355

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***Corresponding author:** Ilseok Kim
Professor, Department of Anesthesiology and Pain Medicine, Kangdong Sacred Heart Hospital, 150 Seongan-ro, Gangdong-gu, Seoul 05355

Abstract **Case Report**

We report a case of retrograde Type A aortic dissection (RAAD) occurring immediately after the initiation of cardiopulmonary bypass via right femoral cannulation for minimally invasive aortic valve replacement. The diagnosis was rapidly confirmed through multimodal monitoring, enabling successful surgical correction. This case highlights the critical importance of multimodal monitoring for the prompt detection and management of RAAD.

Keywords: Retrograde Type A Aortic Dissection, Cardiopulmonary bypass, Femoral cannulation, Transesophageal echocardiography, Regional cerebral oxygen saturation.

INTRODUCTION

Retrograde Type a Aortic Dissection (RAAD) is a rare, yet catastrophic, complication in cardiac surgery, with reported incidence rates falling between 0.04% and 0.29% (von Aspern *et al*., 2022) Timely diagnosis is essential for survival, as this pathology necessitates immediate and complex surgical correction. This case report details the early detection and successful management of an RAAD case that occurred during right femoral artery cannulation for aortic valve replacement (AVR) via a minimally invasive thoracotomy approach in a patient with severe aortic stenosis (AS). The case is particularly notable due to the immediate confirmation provided by various monitoring tools and the successful implementation of a rapid management protocol, emphasizing the critical importance of early recognition.

CASE PRESENTATION

A 68-year-old male with severe AS with bicuspid valve (type0, figure 1), mild dilatation (41-43m) on ascending thoracic aorta, a history of percutaneous coronary intervention for non-ST-elevation myocardial infarction, and remote pulmonary tuberculosis, was scheduled for AVR via a minimally invasive thoracotomy approach.

Upon arrival in the operating room, standard monitoring, including electrocardiography, non-invasive blood pressure, and pulse oximetry, was initiated. The initial vital signs were within the normal range. For additional monitoring, the bispectral index (BIS) was used to assess the depth of anesthesia, and a Masimo monitoring system was utilized to measure regional cerebral oxygen saturation (rSO2). General anesthesia was then induced using propofol and remifentanil via target-controlled infusion, with rocuronium 70 mg administered to facilitate endotracheal intubation. Following the induction of anesthesia, an arterial line was placed in the left radial artery for continuous hemodynamic monitoring. A Swan-Ganz catheter was inserted via the left internal jugular vein (IJV) to monitor pulmonary artery pressures (PAP) and cardiac output, while securing the right IJV for subsequent superior vena cava (SVC) cannulation for cardiopulmonary bypass (CPB). Additionally, a transesophageal echocardiography (TEE) probe was inserted to monitor intraoperative cardiac function.

Arterial cannulation was then performed in the right femoral artery, and venous cannulations were established via the right IJV and right femoral vein for SVC and IVC cannulation, respectively. However, immediately after the initiation of CPB, the patient developed an immediate and significant elevation of PAP coupled with profound hypotension and bradycardia. TEE confirmed the suspected diagnosis, revealing acute widening and dilatation of the ascending aorta with a rapidly propagating intimal flap, definitively suggesting an RAAD. Neurological monitoring provided additional confirmation: the Right rSO2 selectively

dropped from 60% to 40%, indicating acute cerebral malperfusion at the frontal cortex. Immediate cerebral protective measures, including thiopental administration and cooling around the head, were initiated, with the subsequent drop in BIS values (from 40 to 0-10) demonstrating their efficacy of cerebral protection. Simultaneously, the arterial inflow was swiftly switched to the left femoral artery. Following the initiation of arterial inflow via the left femoral artery, blood pressures normalized. The operation was urgently converted to a median sternotomy, allowing the surgery team to perform aortic arch replacement and AVR. The patient demonstrated neurological recovery upon weaning from CPB, with BIS stabilizing at 30–40 and right rSO2 at 50%, and postoperative computed tomography (figure 2) confirmed a Type a retrograde dissection with the re-entry point located in the right external iliac artery. The patient recovered well and was discharged without any neurological sequelae.

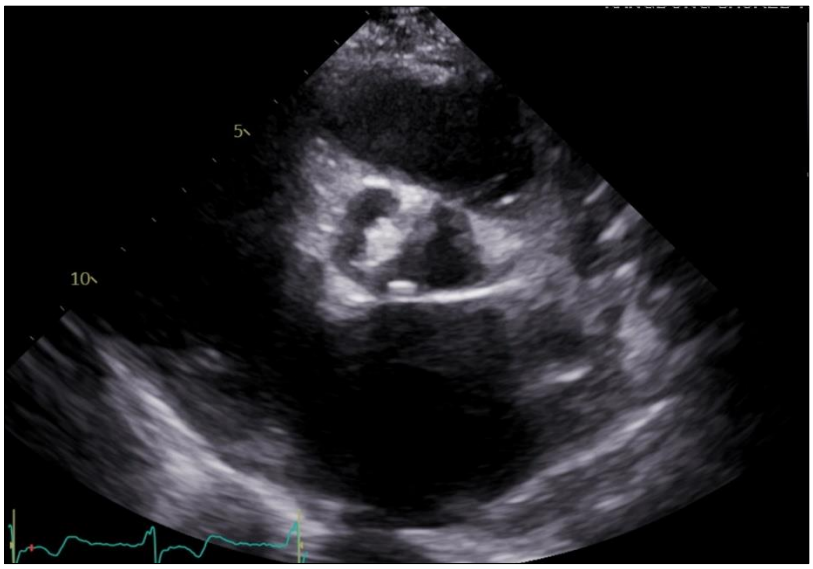

Figure 1: Preoperative Transthoracic echocardiography (TTE) showing a bicuspid aortic valve (BAV) at parasternal short axis view

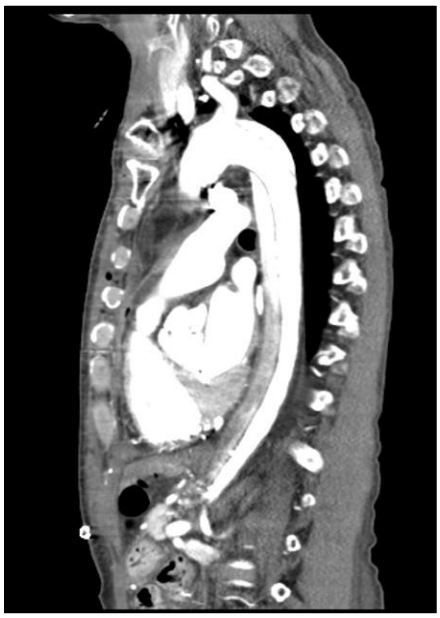

Figure 2: Follow-up CT Angiography (CTA), sagittal view, demonstrating a retrograde aortic dissection originating from the femoral artery and extending to the ascending aorta

DISCUSSION

1. Incidence, Risk Factors, and Mechanism

The occurrence of RAAD is related to patient-specific vulnerabilities. The patient's underlying bicuspid valve is a significant predisposing factor for aortic wall fragility, as bicuspid valve is frequently associated with progressive medial degeneration and dilatation of the ascending aorta due to vascular matrix remodeling (Fedak *et al*., 2002) This pre-existing aortopathy, typically manifesting as an ascending aortic

aneurysm in this patient, is the primary vulnerability that renders the vessel wall fragile and substantially increases the risk of aortic dissection (Isselbacher *et al*., 2022) The primary mechanism of retrograde dissection onset is the hydrodynamic injury caused by the high-velocity, pressure retrograde jet stream emanating from the cannula tip. This mechanism is strongly supported by clinical observation, where dissection lesions associated with arterial cannulation are frequently found on the contralateral wall of the aorta opposite to cannula (Ram *et al*., 2021). Once tear is formed, the continuous high-pressure blood flow from the CPB circuit is directed into the intima-media space, rapidly dissecting the vessel wall and creating a false lumen that propagates proximally from the femoral access site all the way to the ascending aorta.

2. Early Detection via Clinical signs and Neurological Monitoring

Early recognition is the most critical factor determining patient prognosis. While TEE remains the gold standard for visual confirmation (Evangelista, A., *et al*., 2010), rapid hemodynamic deterioration is often the first alert sign. In this case, the sudden and concurrent occurrence of severe hypotension and abrupt PAP elevation immediately signaled obstructive shock. This cardiovascular collapse is caused by the false lumen compressing the true lumen, resulting in sudden occlusion of the aorta. Also, the data from neurological monitoring can be used as an adjunctive tool in detecting ischemic events. Selective decrease in right rSO2 confirmed that the dissecting hematoma compromised the flow to the right-sided cerebral vessels (Bauer *et al*., 2025). The integration of these disparate clinical and monitoring signals allowed for rapid detection.

3. Management Strategy and Favorable Outcome

The successful outcome depends on the immediate and decisive execution of the rescue protocol. Upon strong suspicion of RAAD, the immediate suspension of CPB via false lumen inflow and the swift initiation of brain protective measures (including thiopental administration and cooling the head) were key measures to alleviate ischemic damage, strongly evidenced by rSO2 collapse. (Ram *et al*., 2021) Also some types of cerebral protection maneuvers, such as selective antegrade or retrograde cerebral perfusion can be instituted. A safer alternative arterial inflow was then secured via the Left femoral artery, providing stable systemic perfusion and minimizing the risk of propagating the dissection further via the initial cannulation site. The final surgical approach was appropriately selected, involving both aortic arch replacement and AVR, ensuring complete excision of the pathological tissue and the exclusion of the false lumen. The patient's full neurological recovery, reflected by the stable rSO2 and BIS readings upon weaning and no neurological sequelae after operation, underscores the efficacy of this aggressive and rapid detection to repair strategy.

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