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Case Report

Knotting of Swan–Ganz and Central Venous Catheters in a Post-Heart Transplant Patient on Extracorporeal Membrane Oxygenation: A Rare Case Report

Jia-Jia Jin[1,2,†], Xiang-Ying Pan[2,†], Lian Li[2], Jin-Ning Wang[2], Xin Zhang[2], Tong Li[2,*], Yong-Wei Yu[2,*]

[1]Nursing Department, The First Affiliated Hospital, Zhejiang University School of Medicine, 310003 Hangzhou, Zhejiang, China
[2]Intensive Care Unit, The First Affiliated Hospital, Zhejiang University School of Medicine, 310003 Hangzhou, Zhejiang, China
*Correspondence: drli@mail.zju.edu.cn (Tong Li); yuyongwei@zju.edu.cn (Yong-Wei Yu)
[†]These authors contributed equally.

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Abstract

Background: The Swan–Ganz catheter is widely used for hemodynamic monitoring in critical care, particularly during the perioperative management of cardiac patients. Although complications such as catheter knotting are rare, these complications typically occur during or immediately after catheter insertion. **Case**: We report a unique case of delayed catheter knotting in a 63-year-old male who underwent heart transplantation while receiving venoarterial extracorporeal membrane oxygenation (ECMO) support. The patient initially presented with acute myocardial infarction, refractory heart failure, and multivessel coronary artery disease. Following an unsuccessful emergent coronary intervention, a heart transplant was performed. A Swan–Ganz catheter and a central venous catheter (CVC) were inserted pre-transplantation for monitoring purposes. Postoperatively, right atrial, right ventricular (RV), and pulmonary artery pressures (PAPs) were within normal ranges for the first 48 hours. However, at 55 hours post-transplant, only the right atrial pressure remained detectable, with loss of RV and PAP waveforms. A chest X-ray revealed a rare double-knot entanglement between the Swan–Ganz catheter and the CVC, prompting an urgent multidisciplinary consultation. Given the critical status of the patient, surgical removal via open thoracotomy was performed, successfully resolving the complication. The patient recovered well and remained asymptomatic at the one-year follow-up. This case underscores the uncommon, delayed onset of catheter entanglement, potentially associated with hemodynamic shifts following the transition from adrenaline to dobutamine. The reduced compliance and structural vulnerability of the transplanted heart may have contributed to this complication. The initial bedside ultrasound was inconclusive, highlighting the utility of early chest radiography in similar cases. **Conclusions**: Delayed catheter knotting is a rare but serious complication in heart transplant recipients, particularly those under ECMO support. Thus, proactive imaging and vigilant monitoring during transitions to vasoactive medications are essential to prevent such complications. Additional research is warranted to establish preventive measures and optimize management strategies for patients at high risk of complications.

Keywords

heart transplantation; Swan–Ganz catheter; central venous catheter; venoarterial extracorporeal membrane oxygenation; case report

Introduction

The Swan–Ganz catheter is a specialized medical device primarily used to measure pulmonary artery pressure (PAP) and pulmonary capillary wedge pressure. The Swan–Ganz catheter is 110 cm in length and marked at 10 cm intervals. The balloon, located approximately 1 mm from the catheter tip, can be inflated with 0.8–1 mL of air or carbon dioxide, expanding to a diameter of approximately 13 mm. The catheter is advanced through the superior vena cava into the right atrium (RA) and the pulmonary artery to monitor right atrial pressure, PAP, cardiac output, and other hemodynamic parameters. The Swan–Ganz catheter is frequently used in the perioperative management of patients with heart disease [1,2]. Complications associated with the Swan–Ganz catheter include pulmonary artery rupture, pulmonary infarction, ventricular fibrillation, intravascular catheter knotting, and catheter displacement. The reported incidence of catheter knotting ranges from 0.2% to 2.5%, while entanglement between the Swan–Ganz catheter and a central venous catheter (CVC) is extremely rare [3].

In the context of heart transplantation, the use of both a Swan–Ganz catheter and a CVC is standard practice and clinically essential [4–6]. The Swan–Ganz catheter enables continuous, dynamic monitoring of pulmonary artery pressures, cardiac output, and right heart function—critical for evaluating the performance of the newly transplanted heart

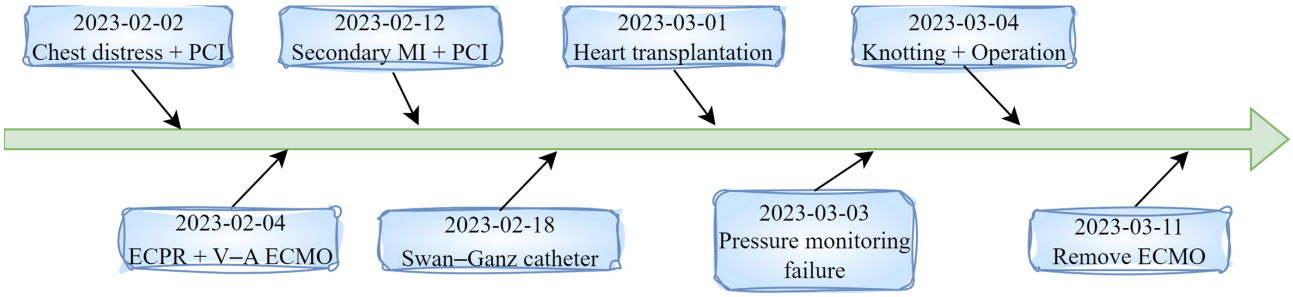

Fig. 1. Flowchart. PCI, percutaneous coronary intervention; ECPR, extracorporeal cardiopulmonary resuscitation; V-A ECMO, venoarterial extracorporeal membrane oxygenation; MI, myocardial infarction.

and guiding vasoactive medication therapy during the vulnerable perioperative phase. In contrast, the CVC provides stable venous access for the administration of inotropes, vasopressors, immunosuppressants, and intravenous fluids, as well as for sampling central venous blood. In patients receiving extracorporeal membrane oxygenation (ECMO) or other forms of advanced cardiac support, central venous access is also vital for fluid management and hemodynamic stabilization. Given the complexity of hemodynamic regulation in cardiac transplant recipients, the simultaneous use of Swan–Ganz and central venous catheters represents a routine and indispensable strategy in contemporary critical care and cardiac anesthesia.

Case Report

A previously healthy 63-year-old male presented to our hospital 11 days prior with the sudden onset of chest tightness. The initial evaluation revealed progressive deterioration of cardiac function, resulting in acute heart and respiratory failure. The patient underwent endotracheal intubation and venoarterial extracorporeal membrane oxygenation (V-A ECMO) under extracorporeal cardiopulmonary resuscitation support (Fig. 1).

Emergent coronary angiography revealed severe multivessel coronary artery disease: 95% stenosis of the left main trunk, 90% stenosis of the left anterior descending artery, total occlusion of the left circumflex artery, and 90% stenosis of the right coronary artery. Despite successful percutaneous coronary intervention (PCI) to restore coronary flow, the cardiac function of the patient remained severely compromised, and we were unable to wean him from V-A ECMO. Consequently, an emergency heart transplantation was performed one day prior while the patient remained on V-A ECMO support. A Swan–Ganz catheter and CVC were inserted via the right internal jugular vein before the transplant, and the patient was transferred to the intensive care unit (ICU) for postoperative monitoring.

Postoperatively, the RA, right ventricular (RV), and PAP measurements were obtained every 8 hours (08:00, 16:00, and 24:00), with all waveforms initially appearing normal. The timeline of vasoactive medication administration following ICU admission is depicted in Fig. 2 (heart rate 80–90 beats/min; mean arterial pressure 75–80 mmHg). For the first 47 hours post-surgery (until March 3 at 16:00), the PAP values remained measurable and within normal limits. However, at 55 hours post-transplant (March 4 at 00:00), only the RA pressure readings were obtainable, and the RV pressure and waveform were completely absent. No procedural changes were made during this interval, aside from the transition from adrenaline to dobutamine.

Subsequently, a bedside ultrasound was performed to investigate the sudden loss of RV and PAP waveforms. However, visualization was inconclusive. A subsequent chest X-ray (Fig. 3A) revealed that the Swan–Ganz catheter had migrated to the proximal superior vena cava and had become entangled and knotted with the CVC. Despite catheter adjustment attempts by the resident physician, a follow-up X-ray confirmed worsening of the entanglement, now presenting as a double knot (Fig. 3B).

Given the critical condition of the patient and the potential for further complications, an urgent multidisciplinary team meeting was convened, involving specialists from the ICU, operating room, radiology, interventional cardiology, cardiothoracic surgery, and vascular surgery. After a thorough assessment, the team concluded that interventional removal was not feasible due to the risk of injury to the transplanted heart and adjacent structures. Therefore, surgical removal via open thoracotomy was determined to be the safest course of action (Fig. 3C).

The patient subsequently underwent a successful thoracotomy, and both catheters were removed without further complications. The patient recovered well and was discharged in a stable condition. Moreover, the patient remained asymptomatic and in good health at the 1-year follow-up.

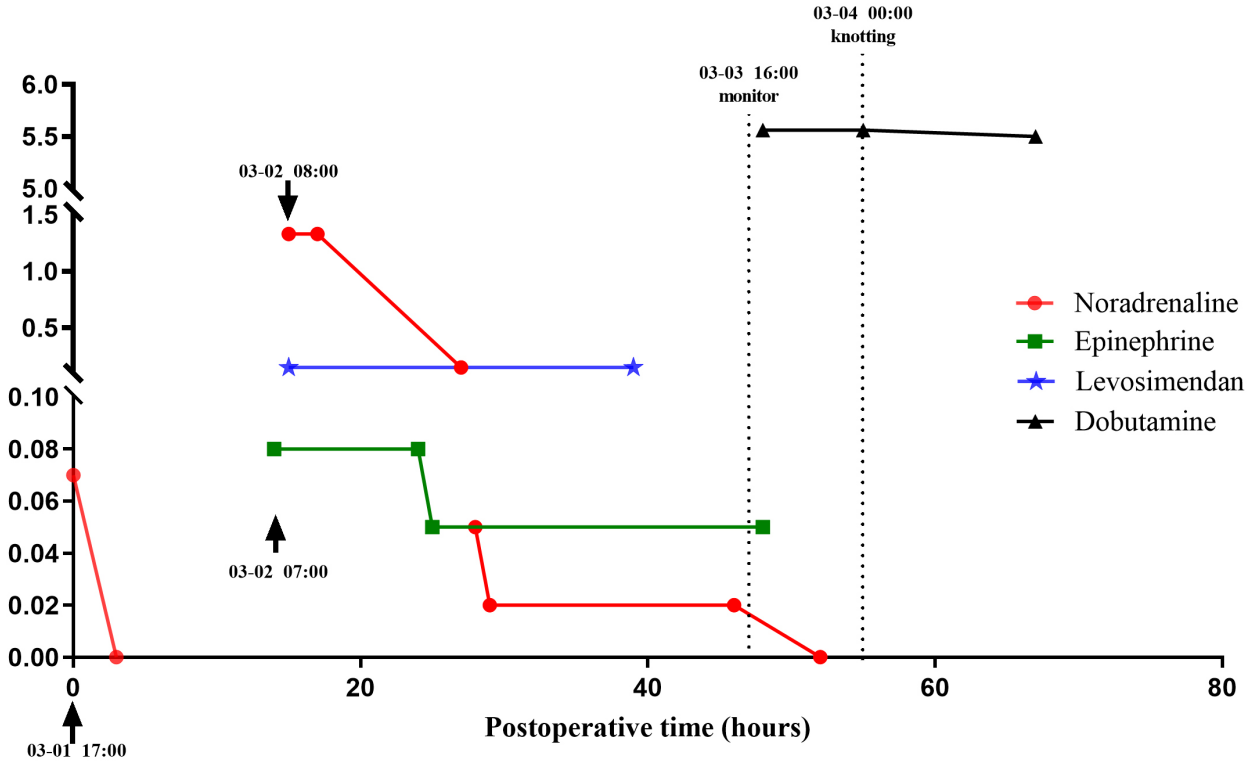

Fig. 2. Vasoactive drugs after heart transplantation (μg/kg/min).

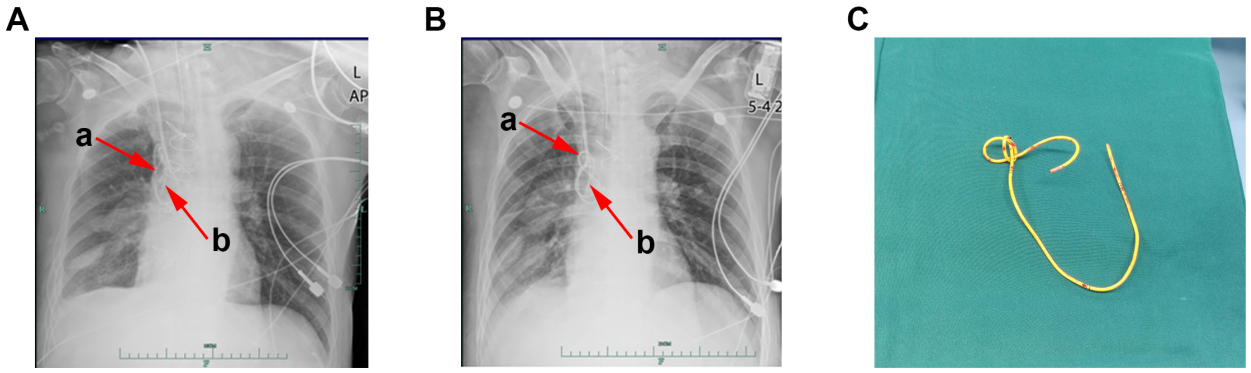

Fig. 3. Chest imaging evidence and catheters. (A) The Swan–Ganz catheter was located in the proximal superior vena cava and was wrapped and knotted with the central venous catheter (CVC). (B) The Swan–Ganz catheter was double-knotted with the CVC. (C) The Swan–Ganz catheter after surgical removal. The red arrow indicates the knotted catheter inside the body.

Discussion

Catheter knotting is a rare but recognized complication of Swan–Ganz catheter placement, most commonly occurring during insertion or manipulation due to excessive advancement or looping within the right heart chambers. Most published cases have attributed knotting to mechanical factors, including improper insertion depth, excessive length of catheter left within the heart, or anatomical variations [7–9]. These reports emphasize the importance of procedural technique and anatomical considerations in knot formation.

However, our case is unusual in that knotting occurred 55 hours after catheter placement, without any manipulation or repositioning of the catheter. Both catheters were initially confirmed to be well-positioned, with normal waveforms maintained for more than 48 hours. This delayed onset of entanglement suggests that non-mechanical, physiological factors may have contributed to the complication.

The Swan–Ganz catheter, introduced by Jeremy Swan and William Ganz, revolutionized hemodynamic monitoring and remains widely utilized in critical care settings [10,11]. Although complications such as catheter entanglement have been reported, including self-knotting, tan-

gling with hemodialysis catheters, and entanglement with CVCs, these typically occur during or immediately following catheterization [3,6,9]. In contrast, our case presents a delayed catheter knotting phenomenon, developing 55 hours postoperatively, well beyond the time of initial placement.

Intraoperative findings confirmed correct catheter positioning, and RV waveforms and pressures remained within normal limits for the first 48 hours following transplantation, effectively ruling out intraoperative misplacement or early catheter malposition. This observation suggests that knotting was unrelated to surgical technique and may instead have resulted from postoperative physiological changes. The rare entanglement in our patient was likely influenced by a combination of reduced ventricular compliance, altered hemodynamic flow patterns, and the presence of multiple intravascular devices.

Of particular interest is the timing of the knotting event, which occurred shortly after the transition from adrenaline to dobutamine. Although there is limited literature directly linking changes in vasoactive agents to catheter movement, we hypothesize that the abrupt hemodynamic shift—from the potent vasoconstrictive and inotropic effects of adrenaline to the vasodilatory and compliance-enhancing effects of dobutamine—may have altered intracardiac flow patterns. These changes could result in subtle repositioning or fluttering of catheter tips, thereby increasing the risk of entanglement, particularly in a low-compliance transplanted heart.

Furthermore, in the early postoperative period following heart transplantation, the grafted heart is often characterized by reduced compliance and structural instability [12]. These physiological properties, combined with abrupt hemodynamic alterations, may render the heart more susceptible to complications related to catheterization. This highlights the importance of vigilant monitoring of catheter positioning, particularly during adjustments of vasoactive medications in critically ill patients.

From a diagnostic perspective, initial bedside ultrasound failed to detect catheter entanglement, likely due to suboptimal image quality associated with altered post-transplant cardiac anatomy. This limitation highlights the challenges of using ultrasound in critically ill patients and reinforces the value of early chest radiography as a complementary diagnostic tool. Routine imaging in patients with multiple indwelling catheters, particularly those with complex postoperative courses, may facilitate the early identification of catheter-related complications.

In summary, while most prior reports attribute catheter knotting to procedural or anatomical causes, our case suggests a potentially under-recognized mechanism involving delayed physiological changes, particularly those induced by pharmacologic hemodynamic modulation. This case highlights the rare yet serious risk of delayed catheter knotting in heart transplant recipients receiving ECMO support. Future studies should aim to delineate the role of drug-induced hemodynamic fluctuations in catheter complications and develop preventive strategies for high-risk populations. According to follow-up records from the transplant program at our center, the patient remained clinically stable and asymptomatic at the one-year follow-up, with continued routine outpatient evaluations.

Abbreviations

PAP, pulmonary artery pressure; PCWP, pulmonary capillary wedge pressure; CVC, central venous catheter; ECPR, extracorporeal cardiopulmonary resuscitation; V-A ECMO, venoarterial extracorporeal membrane oxygenation; PCI, percutaneous coronary intervention; RA, right atrium; RV, right ventricle; HR, heart rate; Map, mean arterial pressure.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

Conceptualization: JJ, TL, YY; Methodology: LL, JW; Software: LL, JW; Validation: JJ, XP; Formal analysis: LL, JW; Investigation: JJ, XP; Resources: JJ, TL; Data Curation: JJ, XP, XZ; Writing-Original Draft: JJ, XP; Writing-Review & Editing: TL, YY; Visualization: JJ, LL, JW; Supervision: XZ; Project administration: XZ; Funding acquisition: NA. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

Ethical approval is not necessary because this is a case report based on the clinical data during the patient's hospitalization other than research and/or experiment. The patient has given his consent and authorized his clinical data in our report and signed the Patient Consent Form.

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Conflict of Interest

The authors declare no conflict of interest. All listed authors consented to the submission of this study, and all the data used were obtained with the consent of the person generating the data.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8559.

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