

Case Report

Central Catheter-Induced Cardiac Tamponade in Neonates: Two Case Reports

Hyungtae Kim¹, Kwang Ho Choi^{1,*}

¹Department of Thoracic and Cardiovascular Surgery, Research Institute for Convergence of Biomedical Science and Technology, Pusan National University School of Medicine, Pusan National University Yangsan Hospital, Yangsan-si, Gyeongsangnam-do 50612, Republic of Korea

*Correspondence: ppippo77@gmail.com (Kwang Ho Choi)

Submitted: 6 June 2023 Revised: 21 September 2023 Accepted: 28 September 2023 Published: 6 November 2023

Abstract

Intraoperative central venous catheter (CVC) insertion has become a routine procedure for pediatric cardiac surgery patients at our center. The case in which large amounts of pericardial effusion resulting in cardiac tamponade other than direct puncture of the catheter is a rare, but often causes fatal complications. Two of our patients suffered cardiac collapse after surgery owing to cardiac tamponade. Both the patients were successfully treated with pericardiocentesis, and the pericardial fluid had a high glucose level. Subsequently, the patients were discharged without any sequelae. During a serial radiographic follow-up, we found a pre-event alteration in the CVC angulation. These two cases highlight the fact that clinicians should pay attention to serial follow-up of chest radiography for monitoring any changes in the catheter status, such as its position or angulation, to prevent unexpected complications. The only way to prevent fatal complications due to CVC is timely recognition of any alteration in CVC based on radiological examinations. In instances of CVC changes, the issues should be addressed as quickly as possible.

Keywords

cardiac tamponade; central venous catheter; thoracotomy

Introduction

Intraoperative central venous catheter (CVC) insertion has become a routine procedure for pediatric cardiac surgery patients at our center. The CVC is commonly used for volume infusion, nutrition, central venous pressure monitoring, and other purposes during and after surgery. Complications related to catheter insertion and maintenance include pneumothorax, hemothorax, hematoma, thrombosis, and infection [1]. However, a large amount of pericardial effusion resulting in tamponade other than direct puncture of the catheter is a rare but often fatal complication [2]. Herein, we share our experience of rare cases of CVC-

Table 1. Summary of patient information.

	Patient 1	Patient 2
Gestational age (weeks)	39 + 2	33 + 4
Birth weight (g)	2740	2020
Diagnosis	CoA	PDA
Indwelling site	Right IJV	Right IJV
Location of tip	Right atrium	Right atrium
Age at catheter insertion (day)	2	22
Age at tamponade (day)	4	27
CPR duration (minutes)	8 + 5	30
Fluid analyses of pericardial effusion		
Total amount of fluid (mL)	37	30
Color	Yellow	Yellow
Glucose (mg/dL)	1341	2695
Lymphocyte (%)	38.7	9
Red blood cell (number/HPF)	6–10	<1

CoA, coarctation of the aorta; CPR, cardiopulmonary resuscitation; IJV, internal jugular vein; PDA, patent ductus arteriosus; HPF, high-power field.

induced cardiac tamponade in two infants who were treated with pericardiocentesis. We also conducted a brief review of the relevant literature regarding this clinical condition to elucidate methods for prompt and accurate diagnosis, and appropriate intervention in patients with CVC-related complications. The CARE checklist was used when writing this case report in **Supplementary Table 1**.

Case Reports

Case 1

A baby weighing 2740 g, born at 39 + 2 weeks of gestation was diagnosed with aortic coarctation. He underwent surgery to repair the aortic coarctation (coarctoplasty) with patent ductus arteriosus (PDA) division via left thoracic approach (thoracotomy) at 2 days of age. On postoperative day (POD) 2, he collapsed with severe bradycardia at 50 beats per minute and a low systolic blood pressure of 36 mmHg. The transthoracic echocardiogram (TTE) showed a large amount of pericardial effusion. Pericardio-

centesis was performed under cardiopulmonary resuscitation (CPR). We only had medical record descriptions and no TTE movie. After pericardiocentesis, vital signs improved. Analysis of 37 mL of pericardial fluid revealed a glucose level of 1341 mg/dL and a red blood cell (RBC) count in the range of 6–10/high power field (HPF) (Table 1). Two days later, he was weaned from the mechanical ventilator and extubated.

Case 2

A baby weighing 2020 g, born at 33 + 4 weeks of gestation was born with a large PDA. The patient underwent PDA ligation via a left thoracotomy at 22 days of age. The postoperative course was uneventful, and he was extubated on POD 2. However, on POD 5, the patient collapsed with a low systolic blood pressure of 28 mmHg. TTE revealed a large amount of pericardial effusion (Fig. 1). We aspirated pericardial fluid of about 30 mL, which revealed a glucose level of 2695 mg/mL and an RBC count of <1/HPF (Table 1). After pericardiocentesis, the vital signs improved. The patient was weaned off the mechanical ventilator and extubated 3 days later.

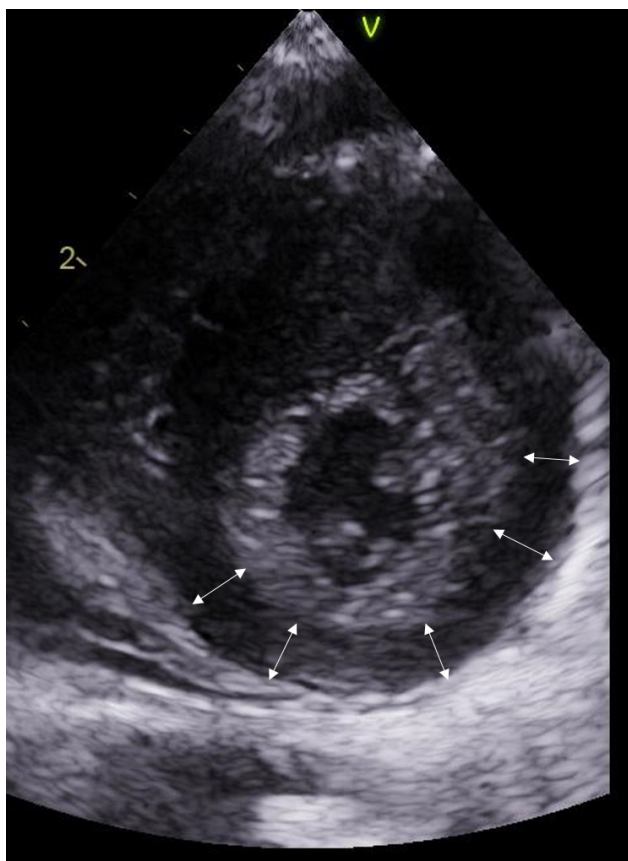


Fig. 1. Short-axis transthoracic echocardiogram of Case 2. The white arrow depicts pericardial effusion.

Fortunately, both patients were discharged without any sequelae. Subsequently, a serial follow-up review of the chest radiographs, revealed that in both cases, there had been a pre-event change in the angulation of the CVC (Fig. 2).

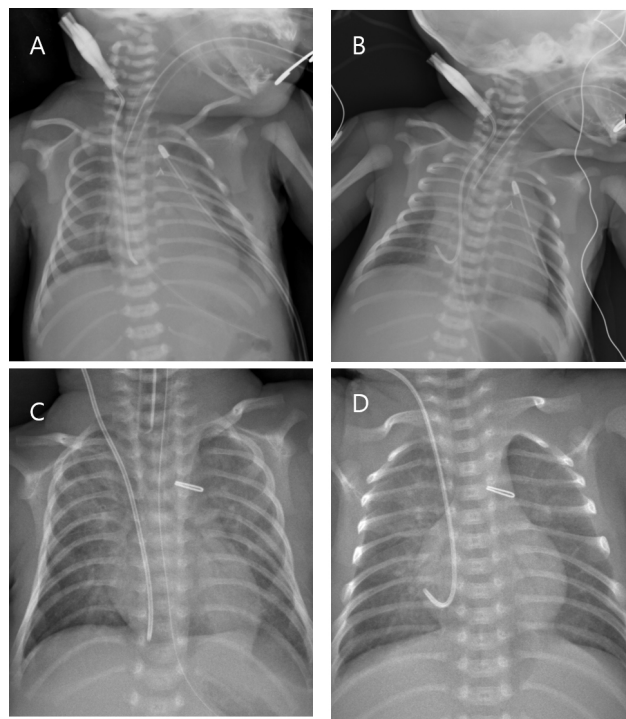


Fig. 2. Serial chest X-rays of the two patients. These chest X-rays were acquired before the tamponade events. (A,B) Chest X-rays of pre- and post-angulation of case 1; and (C,D) Chest x-ray of pre and post-angulation of case 2.

Discussion

CVC-induced pericardial effusion or tamponade is a rare but fatal complication, with a mortality rate of 65% [2]. Weil *et al.* [3] reported that the mortality rate in patients who underwent pericardiocentesis was 8% compared with 75% in patients who did not undergo pericardiocentesis. Several theories of CVC-induced cardiac tamponade have been proposed including direct perforation, however, in our cases, we could exclude direct perforation based on the fluid analysis and post-event course. The fluid analysis of our patients yielded low RBC count and high glucose level. Also, the composition of the lymphocyte in fluid analysis is too low to confirm as chylothorax (Table 1). One possible mechanism for this may be that the solution can penetrate the atrial wall as filter paper because the atrial wall of neonates is immature and thin. Darling *et al.* [4] reported five cases of cardiac tamponade with altered catheter angulation and emphasized that the tip in the right atrium

was a risk factor for neonatal tamponade. The two cases in our study showed changes in CVC angulation toward the right lateral side, which could have resulted following direct catheter contact with the right atrial wall; this might be the reason for cardiac tamponade. In the previous case report, peripherally inserted central venous catheters (PICC) have the same risk of cardiac tamponade during the neonatal period, and the cardiac tamponade resolved by removing the PICC and performing pericardiocentesis [5]. However, we pulled back the CVC by several centimeters instead of removing it after pericardiocentesis, and there was no recurrent problem. Gupta *et al.* [6] reported the tip-migration rates for umbilical venous catheter (UVC) and PICC. The UVC migration rates were 36% at 1 hour and 23% at 24 hours whereas those of the PICC tip were 23% at 1 hour and 11% at 24 hours after insertion. Also, these authors emphasized the need for serial radiographic evaluations of the catheter tip location in neonates to maintain a proper CVC position [6].

In our center, CVC insertion via the internal jugular or subclavian vein is performed in all patients undergoing heart surgery; in cases where there is a need to open the right atrium, the surgeon cuts the catheter near the superior vena cava junction. However, the present cases were not open-heart surgeries; thus, we did not touch the CVC after the anesthesiologist had inserted it. As we missed the changes regarding CVC angulation during the postoperative period, the patients suffered from cardiac tamponade. In addition, these are very rare cases because the incidence of this complication was 0.08% at our institution in consideration of the total of 2518 cardiac surgeries performed at our institution during the study period.

Conclusion

In conclusion, we described two rare cases of CVC-induced cardiac tamponade due to unexpected changes in CVC angulation in neonates who were treated with pericardiocentesis with providing data of the clinical and radiological findings. As shown in our case, the rarity of CVC-induced cardiac tamponade can lead to a challenging diagnosis. Therefore, the experiences acquired from our study indicate that meticulous serial radiographic evaluations of central venous line placements in neonates are important to monitor any change in the catheter position or angulation. If the catheter angulation is changed, surgeons should pull back or removed immediately the catheters and confirm actions using TTE. This can prevent fatal outcomes.

Author Contributions

Conceptualization, KHC; methodology, KHC; validation, HK; formal analysis, KHC and HK; writing—

original draft preparation, HK; writing—review and editing, KHC. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The protocol was proved by the Institutional Review Board of Pusan National University Yangsan Hospital as follows: PNUYH IRB 05-2023-010. As per our Institutional Review Board guidelines, patient consent for this case report was waived owing to the retrospective nature of the study, which did not alter patient management or clinical outcomes.

Acknowledgment

We would like to thank Editage (<https://www.editage.co.kr>) for English language editing.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.59958/hsf.5825>.

References

- [1] Askegard-Giesmann JR, Caniano DA, Kenney BD. Rare but serious complications of central line insertion. *Seminars in Pediatric Surgery*. 2009; 18: 73–83.
- [2] Keeney SE, Richardson CJ. Extravascular extravasation of fluid as a complication of central venous lines in the neonate. *Journal of Perinatology: Official Journal of the California Perinatal Association*. 1995; 15: 284–288.
- [3] Weil BR, Ladd AP, Yoder K. Pericardial effusion and cardiac tamponade associated with central venous catheters in children: an uncommon but serious and treatable condition. *Journal of Pediatric Surgery*. 2010; 45: 1687–1692.
- [4] Darling JC, Newell SJ, Mohamdee O, Uzun O, Cullinane CJ,

Dear PR. Central venous catheter tip in the right atrium: a risk factor for neonatal cardiac tamponade. *Journal of Perinatology: Official Journal of the California Perinatal Association*. 2001; 21: 461–464.

[5] Hou A, Fu J. Pericardial Effusion/Cardiac Tamponade Induced by Peripherally Inserted Central Catheters in Very Low Birth

Weight Infants: A Case Report and Literature Review. *Frontiers in Pediatrics*. 2020; 8: 235.

[6] Gupta R, Drendel AL, Hoffmann RG, Quijano CV, Uhing MR. Migration of Central Venous Catheters in Neonates: A Radiographic Assessment. *American Journal of Perinatology*. 2016; 33: 600–604.