

Transarterial closure of patent ductus arteriosus in a child complicated with absence of inferior vena cava: A case report and literature review

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Introduction

Patent ductus arteriosus (PDA) is a congenital cardiovascular disease in which a fetal connection between the aorta and pulmonary artery fails to spontaneously close shortly after neonate birth. If left untreated, PDA might lead to severe cardiac complications and even death. Surgical ligation is the conventional surgical option. Nevertheless, it is an invasive procedure, which instead motivates development of minimally invasive interventional occlusion [1]. In recent years, although open chest and video-assisted interruption are still being adopted, transcatheter occlusion has rapidly become the optimal choice for the occlusion of PDA in eligible patients. Standardized percutaneous PDA occlusion is to establish a track through the femoral vein-inferior vena cava-right atrium-right ventricle-main pulmonary artery-ductus arteriosus-descending aorta route and deliver the occluder to the aortic end. However, in patients with absence of inferior vena cava (IVC), the lack of a normal inferior vena cava system poses significant challenges for the success of interventional occlusion. Alternative routes for PDA occlusion should be explored. In this study, we reported the diagnosis and successful PDA occlusion in a 3-year-old girl diagnosed with PDA complicated with IVC absence as follows.

Case report

A 3-year-old girl, weighing 13.5 kg, presented with "abnormal cardiac murmur" during physical examination one month ago, and echocardiography showed the following findings: funnel-type PDA; mild tricuspid regurgitation and estimated PASP of 24 mmHg. In line with the indications for interventional operation, the patient was admitted to our hospital and scheduled to undergo percutaneous PDA occlusion. Physical examination on admission showed that the relative dullness of the heart was normal, and continuous mechanical murmur could be heard between the 2nd and 3rd intercostal space at the left margin of the sternum. Electrocardiogram showed sinus rhythm. The posterior and anterior radiographs of the chest showed increased pulmonary blood and heart enlargement. The procedure was performed guided by fluoroscopic and transthoracic echocardiography under general anesthesia. It was difficult to insert the guidewire (Cordis, Cardinal Health, U.S.) through the femoral vein to the IVC (Figure 1A), and then angiography was performed through the femoral vein, showing that the inferior vena cava was absent and the veins formed

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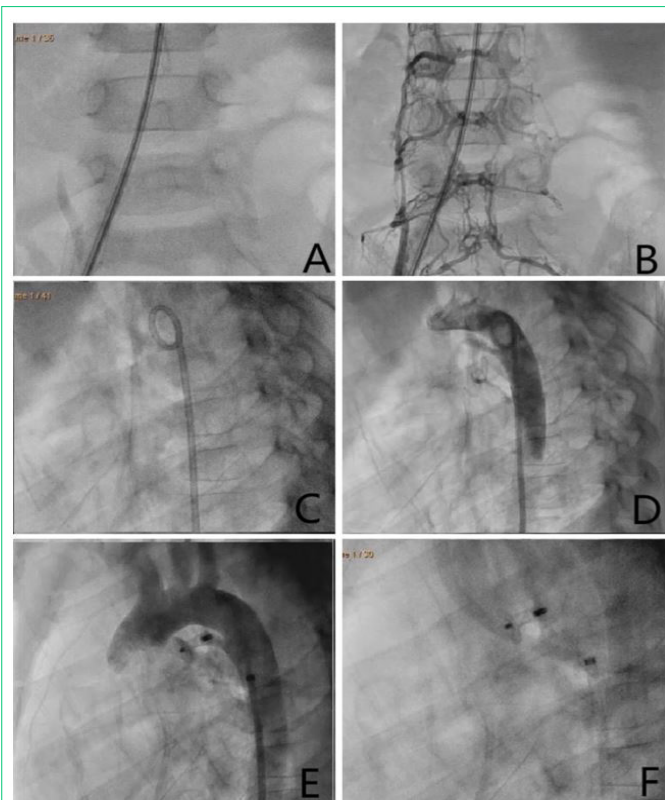


Figure 1: (A) Difficulty in the anterograde insertion of the guidewire via the femoral vein; (B) Angiography showing the absence of inferior vena cava; (C-D) Aortography showing patent ductus arteriosus; (E-F) Aortic angiography showing no residual flow across the device and Lifetech 4 mm×6 mm occluder is successfully deployed.

Table 1: Literature review of device closure for patent ductus arteriosus complicated with interruption/absence of vena cava.

Author	Publication year	Age	Gender	PDA size (mm)	Surgical route
Al-Hamash [5]	2006	9 years	Female	4	Femoral vein
		3 years	Male	4	Femoral vein
Sivakumar et al. [6]	2007	N/A	N/A	8	Femoral artery
Koh et al. [7]	2009	37 years	Female	3.5	Femoral artery
Patel et al. [8]	2009	9 years	Female	5.1	IJV
Celebi et al. [9]	2013	3 months	Female	4.3	Femoral artery
Tefera et al. [10]	2014	12 years	Female	5	Femoral vein
Subramanian et al. [11]	2014	18 months	N/A	4.7	IJV
Aggarwal et al. [12]	2015	3 years	Female	3	IJV
Jawahirani et al. [13]	2018	5 years	Female	6	IJV
Rajan et al. [14]	2021	3 years	Male	4	Femoral vein
		3 years	Male	3	Femoral vein
		2 years	Female	4	Femoral artery
		6 years	Female	2	Femoral artery

Abbreviations: IJV: Internal jugular vein, N/A: Not available.

an ascending network (Figure 1B). Aortography was performed via the 6-Fr arterial sheath (LifeTech Scientific Corporation, Shenzhen, China) into the pigtail tube and showed the presence of PDA (Figure 1C-D). Hence, alternative routes should be urgently considered. Transcatheter occlusion via the right subclavian vein or right internal jugular vein-right atrium-right ventricle-pulmonary artery-PDA-descending aorta route was considered. However, considering the young age of this patient, the procedures of transvenous occlusion through the right subclavian vein or right internal jugular vein were complicated, which was likely to cause shear force injury. Eventually, the occluder was deployed from the descending aorta to the pulmonary artery via PDA, and the 4 mm×6 mm occluder device (LifeTech Scientific Corporation, Shenzhen, China) was deployed at the pulmonary-artery end of PDA. The occluder was deployed in proper shape and position and was completely released (Figure 1E). Transthoracic echocardiography showed that the occluder was fixed without residual flow across the device and the original heart murmur disappeared. Aortic angiography showed no residual flow across the occluder device (Figure 1F). No intraoperative complications, such as bradycardia or hypotension, were observed. During postoperative 3-month follow-up, the patient was generally in good condition, without any discomfort. Echocardiography showed that the occluder was deployed in proper position without residual flow across the device.

Discussion

Absence of the IVC is a relatively rare congenital cardiovascular malformation, with an incidence of approximately 0.1%-0.6% worldwide, with a higher incidence of 1-3% among patients with congenital heart disease [1]. Right heart catheterization,

selective cardiovascular angiography, CT, and MRI examinations can confirm the diagnosis [2-4]. Echocardiography is helpful to discover the ectopic connection of the IVC, and routine exploration of the location and direction of the IVC contributes to clinical diagnosis. For patients with congenital heart disease, the risk of malformations of the surrounding large vessels should be considered. Congenital heart disease with IVC absence, when conventional track cannot be established, transcatheter occlusion is required through a special route. Standardized percutaneous PDA occlusion route via the vein-IVC-right atrium-right ventricle-main pulmonary artery-ductus arteriosus-descending aorta to establish a track and deliver the occluder to the aortic end. In this report, the girl was diagnosed with IVC absence and the veins formed an ascending network. Intraoperatively, the guide wire could not be delivered to pulmonary artery through the IVC. Finally, a track was established through the femoral artery-descending aorta-pulmonary artery-right ventricle route, and the occluder device was deployed to the pulmonary artery end. PDA complicated with IVC absence is a rare cardiovascular malformation. We conducted literature review from 2006 to 2022 and searched 14 cases of PDA complicated with IVC absence (Table 1), mainly aged 3 months to 12 years, only 1 adult aged 37 years. Among 14 patients, femoral artery route was adopted in 5 cases [6,7,9,14], 5 cases of femoral vein route [5,10,14] and 4 cases of IJV [8,11,13]. These findings suggest that individualized route should be established and adopted according to the specific condition of each patient. In the present case, the occluder device was fixed mainly with radial force, and the risk of postoperative occluder malposition should be considered. Postoperative 3-month follow-up showed that the occluder device was maintained in a proper position.

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