Cardiology in the Young

cambridge.org/cty

Post-Patent Ductus Arteriosus ligation syndrome with hypertension and masking of renal artery stenosis in an infant

Erica E. ElSeed Peterson[1] and Daniel Mauriello[2]

[1]Department of Pediatrics, University of South Florida, Resident Physician, Tampa, FL, USA and [2]Division of Pediatric Cardiology, Johns Hopkins All Children's Assistant Professor, St. Petersburg, FL, USA

Brief Report

Cite this article: ElSeed Peterson EE, Mauriello D. (2018) Post-patent ductus arteriosus ligation syndrome with hypertension and masking of renal artery stenosis in an infant. *Cardiology in the Young* **28**: 737–738. doi: 10.1017/S1047951117002803

Received: 13 August 2017
Revised: 24 October 2017
Accepted: 24 November 2017
First published online: 7 February 2018

Key words:
Renal artery stenosis; post-patent ductus arteriosus ligation syndrome; patent ductus arteriosus; hypertension

Author for correspondence:
EEE Peterson, USF Health, Pediatrics, 2 Tampa General Circle, Room 5036, Tampa, Florida, USA. Tel: 813 259 8725;
E-mail: eelseed@health.usf.edu

Abstract

Post-patent ductus arteriosus ligation syndrome is common, but rarely has hypertension been described following ductal ligation with an unclear mechanism. We report a case of an infant who exhibited features of post-patent ductus arteriosus ligation syndrome and hypertension, but was found to have bilateral renal artery stenosis. Increased systemic vascular resistance can be masked by the parallel circuit physiology of a patent ductus arteriosus.

Case

A female infant was born at 38 1/7 weeks of gestation weighing 4 kg. The pregnancy was complicated by prenatal suspicion of heterotaxy syndrome, polyhydramnios, and type 1 diabetes. The infant was admitted to the Neonatal ICU owing to prenatal diagnoses of heterotaxy syndrome in addition to hypoglycaemia at birth.

On day of life 1, an echocardiogram demonstrated interrupted inferior caval vein, midline liver, mid-muscular ventricular septal defect, secundum atrial septal defect, biventricular hypertrophy, mildly dilated right atrium and ventricle, and a large patent ductus arteriosus with bidirectional shunting. There was suspicion of left ventricular non-compaction. The remaining intracardiac anatomy appeared normal. An abdominal ultrasound was also done, which demonstrated right-sided stomach and midline liver.

On admission to the NICU, an umbilical artery line was placed for administration of dextrose given hypoglycaemia. The infant required two boluses of D10 (2 ml/kg each). She was started on IV fluids containing dextrose while beginning to feed orally with formula. Fluids were weaned off by day of life 3. She was discharged on day of life 5 as she was haemodynamically appropriate with instructions for outpatient follow-up with cardiology and to monitor for development of tachypnoea, poor feeding, and diaphoresis. She followed up with cardiology on day of life 7, and she was found to have tachypnoea and hepatomegaly. On echocardiogram, there was evidence of persistence of the ductus arteriosus. She was subsequently re-admitted for congestive heart failure and started on IV furosemide at a dose of 1 mg/kg twice daily and PO captopril at a dose of 0.1 mg/kg twice daily. She received one round of intravenous indomethacin. Despite maximal medical therapy, she still exhibited symptoms of congestive heart failure. On day of life 13, she remained tachypnoeic with respirations up to 100 breaths per minute and oxygen saturations in the upper 70s on room air, for which she was placed on high-flow nasal cannula 2 L/minute at 21% oxygen. Her blood pressures measured between 99/56 and 67/31 mmHg. Owing to persistent symptoms of heart failure, she underwent attempt at transcatheter device closure of the ductus arteriosus on day of life 15. However, the anatomy was not favourable. Video-assisted thoracoscopic ligation of the ductus was subsequently performed uneventfully.

On post-operative day 1, the infant developed systemic hypertension with moderate to severely depressed left ventricular systolic function with an ejection fraction of 25%. Signs of pulmonary hypertension included dilation of the right ventricle and right atrium with pulmonary valve regurgitation, severe tricuspid valve regurgitation, and main pulmonary artery pressure of 146 mm Hg. She was re-intubated owing to respiratory failure secondary to decreased left ventricular function and pulmonary hypertension. Because of sustained systemic systolic pressures >110 mmHg, she was started on a 0.8 mcg/kg/minute nitroprusside infusion. Despite the addition of 1 mcg/kg/minute milrinone and 20 ppm inhaled nitric oxide, systolic blood pressures remained >110 mgHg. A renal ultrasound demonstrated normal-sized kidneys, but with abnormally high resistive indices of 1.0 bilaterally, which was considered non-specific but related to intrinsic renal disease. An abdominal CT angiogram showed bilateral hypoplastic renal arteries. The right renal artery measured 1.2 mm and the left measured 1.8 mm. Nitroprusside drip was titrated up to 3 mcg/kg/minute with addition of hydralazine 0.1 mcg/kg given as needed.

CAMBRIDGE UNIVERSITY PRESS

By post-operative day 6, systolic blood pressures improved and nitroprusside was successfully discontinued. Inhaled nitric oxide was discontinued on post-operative day 9 and milrinone was discontinued on post-operative day 12. Oral enalapril, 0.1 mg/kg twice daily, was added. Repeat echocardiogram on post-operative day 14 found that the left ventricular function improved to low-normal. Supplemental oxygen was required until post-operative day 24. She was maintained on enalapril for left ventricular non-compaction. The last echocardiogram before discharge showed mildly hypertrophied and heavily trabeculated left ventricular endocardium with preserved systolic function, secundum atrial septal defect, and right ventricle systolic pressure less than half systemic. She was discharged home after undergoing Ladd's procedure for malrotation and gastric tube placement. Her blood pressures remained normal throughout the remainder of her hospitalisation.

Discussion

Post-patent ductus arteriosus ligation syndrome, with depressed systemic ventricular function following ductus closure, is a phenomenon that has been well described. The mechanism behind post-ligation cardiac syndrome is thought to be multifactorial. A non-restrictive ductus results in parallel circulations of the systemic and pulmonary circuits. The total resistance of the combined pulmonary and systemic circuits is less than either alone. This results in decreased afterload for the systemic left ventricle. Following ligation or closure of the ductus, the systemic ventricle is required to suddenly work against an increased afterload as blood from the higher resistance systemic circuit can no longer be diverted to the pulmonary circuit. In addition to the sudden elevation in systemic vascular resistance following ductus ligation, there is a decrease in pulmonary venous return resulting in reduced preload.[1] These combined effects can lead to a decrease in cardiac performance and depression of systemic ventricular function by the neonatal heart, which has been unaccustomed to the increased afterload.[1,2] Depending on the degree of ventricular dysfunction, patients can become hypotensive requiring inotropic support.

Rarely hypertension has been described following ductus ligation. Typically, when reported, the elevations in systemic blood pressure after ductus ligation have been transitory. Sustained, elevated systemic pressures despite multiple drug therapies is uncommon.[3] Likely involved in this pathophysiology is the renin–angiotensin–aldosterone system. The large left-to-right shunting across the ductus results in decreased perfusion to the systemic circulation including renal vasculature.[2] As a result of renal hypo-perfusion, renin increases angiotensin, which ultimately leads to vasoconstriction, sodium retention, and increased blood pressure. Our patient had an additional contributing factor of renal artery stenosis adding to further limit renal perfusion and increase systemic vascular resistance. This effect of increased systemic resistance was masked while the ductus was patent, allowing the systemic systolic blood pressure to remain normal. The bilateral renal stenosis in addition to the large ductal shunt contributed to renal hypo-perfusion and alteration of the renin–angiotensin–aldosterone system. These factors may explain her elevated systemic pressures following ductal ligation in addition to the post-ligation cardiac syndrome and depressed systemic ventricular function. The parallel circuit physiology of a non-restrictive ductus explains why renal artery stenosis and other abnormalities that increase systemic resistance can be masked and challenging to diagnose while the ductus is present.

Conclusion

Following ductus arteriosus ligation, hypertension has been infrequently described. This case demonstrates how physiologic states of increased systemic vascular resistance, such as those with renal artery stenosis, can be masked by the parallel circuit physiology of a patent ductus arteriosus. Persistent hypertension following ductus ligation should prompt an investigation into causes of increased systemic resistance, which may have been masked by the parallel circuit physiology created with a patent ductus.

Acknowledgements. The authors would like to acknowledge Dr Claude Guidi, M.D. for his assistance with diagnostic imaging review.

Financial Support. None.

Conflicts of Interest. This research received no specific grant from any funding agency or commercial or not-for-profit sectors.

References

1. Kimball KR, Ralston MA, Khoury P, et al. Effect of ligation of patent ductus arteriosus on left ventricular performance and its determinants in premature neonates. JACC 1996; 27: 193–197.
2. El-Khuffash AF, Jain A, McNamara PJ, et al. Ligation of the patent ductus arteriosus in preterm infants: understanding the physiology. J Pediatr 2013; 162: 1100–1106.
3. Davierwala P, Thakur N, Babu P. Unexplained systemic hypertension after closure of ductus arteriosus. Asian Cardiovasc Thorac Ann 2002; 10: 78–79.

https://doi.org/10.1017/S1047951117002803 Published online by Cambridge University Press