Journal of the Society for Cardiovascular Angiography & Interventions 3 (2024) 102386

JSCAI

The official journal of the Society for
Cardiovascular Angiography & Interventions

Pearls in Hemodynamics

Hemodynamic Evaluation in Temporary Atrial Septal Defect Occlusion

Benjamin L. Magod, MD [a,*], Yasmin Raza, MD [b], Jeremy L. Fox, MD [c], Kelley Chen, MD [b], Marysa V. Leya, MD [b], Paul Tannous, MD, PhD [c], Daniel R. Schimmel, MD [b]

[a] *Department of Medicine, Northwestern University Feinberg School of Medicine, Chicago, Illinois;* [b] *Division of Cardiology, Northwestern University Feinberg School of Medicine, Chicago, Illinois;* [c] *Division of Cardiology, Department of Pediatrics, Ann and Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, Illinois*

Case report

A 43-year-old woman with an unrepaired secundum atrial septal defect (ASD) complicated by pulmonary arterial hypertension with congenital heart disease (APAH-CHD) and chronic hypoxemia secondary to possible interstitial lung disease presented for not only consideration of ASD closure but also being evaluated for possible lung transplant. Echocardiography demonstrated bidirectional shunting across the 12.0 × 28.0-mm ASD. Despite maximally tolerated combination pulmonary vasodilator therapy, her pulmonary artery (PA) systolic pressure was greater than two-thirds systemic systolic pressure (ratio being 0.78), which raised concern about class III indication for ASD closure.

Therefore, she underwent temporary ASD occlusion to evaluate hemodynamic response. The baseline hemodynamics showed a Q_{eff} of 6.1, $Q_{L\text{-}R}$ of 3.2, $Q_{R\text{-}L}$ of 1.1, pulmonary vascular resistance of 4.3 WU, and net left-to-right shunt fraction with pulmonary flow to systemic flow (Q_p/Q_s) ratio of 1.29. The ASD was occluded with a 34.0-mm Amplatzer sizing balloon with intracardiac echocardiography and fluoroscopy guidance. The hemodynamics and saturations were then re-measured (Figure 1).

Discussion

Invasive hemodynamic evaluation is critical in identifying and treating shunt physiology and CHD lesions. This patient's ASD led to severe right heart dysfunction, APAH-CHD, and subsequent partial shunt reversal and Eisenmenger syndrome. The European Society of Cardiology and American College of Cardiology/American Heart Association guidelines recommend against closure in the presence of Eisenmenger syndrome or PA systolic pressure greater than two-thirds systemic systolic pressure, 2 criteria that this patient met.[1,2] However, initiation of medical therapies may lower pulmonary vascular resistance to a point that the patient may tolerate and, even benefit from, ASD closure.[3]

Given the progression of this patient's APAH-CHD, the ASD may act to relieve right-sided pressure overload. If closed, the result may be an abrupt increase in right ventricular and PA pressures. With bidirectional shunt, and in the setting of left ventricular diastolic dysfunction, closure can also lead to a rise in left-sided pressures and subsequent pulmonary edema, worsening pulmonary hypertension, or arrhythmias. Particularly in adult patients, temporary closure with hemodynamic evaluation is an informative tool before ASD closure.[4] Saturation measures demonstrated shunt at the level of the right atrium, with balloon occlusion measurements confirming appropriate and complete closure of the lesion. Subsequent hemodynamic measurements showed tolerance of ASD closure with improvement in PA pressures without increased left-sided pressures (Figure 1). Ultimately, percutaneous closure options, both with or without fenestrated devices, were deemed unfeasible due to insufficient rims. Consequently, the patient underwent surgical ASD repair and single lung transplantation for interstitial lung disease soon after this temporary closure evaluation. The procedure was well-tolerated. This case emphasizes the value of pulmonary-to-systemic flow ratios and invasive hemodynamic assessments in the evaluation of adult patients with ASD, particularly in individuals with pulmonary hypertension.

Pearls in Hemodynamics

- Invasive hemodynamics and pulmonary-to-systemic flow ratios can help delineate bidirectional shunts.
- Temporary balloon occlusion should be strongly considered prior to ASD closure to inform treatment decisions, especially in cases where there are concerns about tolerance of defect closure.
- Ensuring complete closure based on intraoperative imaging, pressure tracings, and saturation measurements allows for precise verification and accurate measurements.

Declaration of competing interests

The authors of this manuscript have no declarations of interest to disclose.

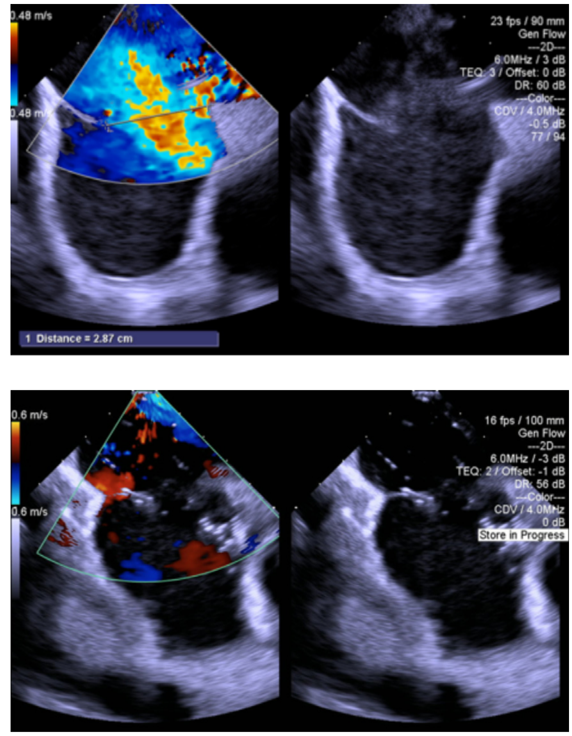
Keywords: adult congenital heart disease; atrial septal defect; hemodynamics.
* Corresponding author: benjamin.magod@nm.org (B.L. Magod).

https://doi.org/10.1016/j.jscai.2024.102386
Received 2 June 2024; Received in revised form 20 August 2024; Accepted 25 August 2024; Available online 23 September 2024

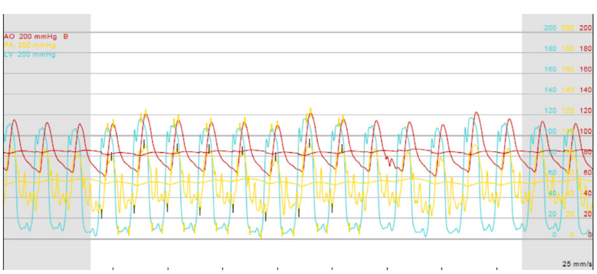
A

MEASUREMENTS	BASELINE	BALLOON OCCLUSION
CVP	14	10
RA PRESSURE	17/11 (13)	13/9 (10)
RV PRESSURE	88/8	60/10
PA PRESSURE (mPAP)	88/30 (49)	60/30 (40)
Ao	113/65 (81)	102/65 (82)
LVEDP*	9	10
PASP/SBP RATIO	0.78	0.59
Qp:Qs	1.29	1
PVR (WU)	4.3	5.2
SVR (WU)	9.3	11.6
SATURATIONS (%)		
IVC	75.5	67.4
SVC	68.6	69.5
RA	84.9	66.8
RV	81.7	61.4
PV	98.6	-
PA	80	62.6
AO	94.2	92.3

B ECHOCARDIOGRAPHY



C PRE-CLOSURE



D POST-CLOSURE

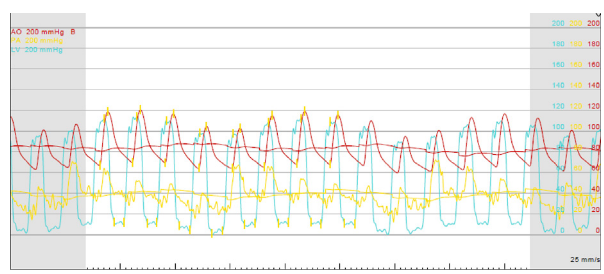


Figure 1.
(A) Hemodynamic and saturation measurements. (**B**) Baseline and stop-flow echocardiography images. Pressure tracings of PA (yellow), LV (blue), and AO (red) at baseline (**C**) and post-balloon occlusion (**D**). *LVEDP was used as a surrogate for pulmonary capillary wedge pressures in calculations. CVP, central venous pressure; IVC, inferior vena cava; LV, left ventricular; LVEDP, left ventricular end-diastolic pressure; PA, pulmonary artery; PASP, pulmonary artery systolic pressure; PV, pulmonary vein; PVR, pulmonary vascular resistance; RA, right atrial; RV, right ventricular; SBP, systolic blood pressure; SVC, superior vena cava; SVR, systemic vascular resistance.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics statement and patient consent

Institutional review board oversight was not required for this case report. This case study adhered to the pertinent ethical guidelines, and the patient signed an informed procedural consent.

References

1. Baumgartner H, De Backer J. The ESC clinical practice guidelines for the management of adult congenital heart disease 2020. *Eur Heart J*. 2020;41(43):4153–4154.
2. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC guideline for the management of adults with congenital heart disease: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *J Am Coll Cardiol*. 2019;73(12):e81–e192.
3. Yan C, Pan X, Wan L, et al. Combination of F-ASO and targeted medical therapy in patients with secundum ASD and severe PAH. *JACC Cardiovasc Interv*. 2020;13(17):2024–2034.
4. Miranda WR, Hagler DJ, Reeder GS, et al. Temporary balloon occlusion of atrial septal defects in suspected or documented left ventricular diastolic dysfunction: hemodynamic and clinical findings. *Catheter Cardiovasc Interv*. 2019;93(6):1069–1075.