

Beyond morphometry: the atrial septal defect pressure gradient as a dynamic predictor of mitral valve growth in borderline left hearts

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Key message

Traditional morphometric scores often fail to predict the success of biventricular repair of borderline left hearts. Wang et al. demonstrated that a low atrial septal defect (ASD) pressure gradient is a critical functional predictor of mitral valve growth. By integrating ASD hemodynamics with anatomical data, clinicians can better identify candidates for biventricular repair, proving that the "grey zone" is narrower than previously thought and improving outcomes for vulnerable neonates.

The management of infants with coarctation of the aorta (CoA) or an interrupted aortic arch (IAA) alongside borderline left-sided structures remains among the most complex challenges in pediatric cardiac surgery. Neonates born with borderline left heart hypoplasia or hypoplastic left heart complex can be candidates for biventricular repair, whereas those with severe hypoplasia typically require single-ventricle palliation.¹⁾ Because failed biventricular repair often leads to poor clinical outcomes,²⁾ there is a critical need for more accurate predictive factors to guide high-stakes decisions. To identify suitable candidates for biventricular repair, several prediction models such as the Rhodes, CHSS (Congenital Heart Surgeons' Society), Discriminant, and 2V scores have been developed³⁻⁷⁾; however, their predictive accuracy remains limited. These models primarily utilize morphometric parameters, including mitral valve (MV) size, left ventricular (LV) dimensions, aortic valve size, the presence of an apex-forming LV, and endocardial fibroelastosis. Because morphometry alone does not enable precise predictions, clinicians frequently supplement these scores with functional assessments such as LV function, LV end-diastolic pressure, and blood flow direction in the ascending aorta and the patent ductus arteriosus to improve prediction

accuracy.

In a recent study published in *Clinical & Experimental Pediatrics*, Wang et al.⁸⁾ investigated the clinical outcomes and influence of the hemodynamic characteristics of atrial septal defect (ASD) on MV growth after surgical repair in infants with CoA or IAA, using a retrospective analysis of 161 patients. Consistent with previous reports, the authors found that biventricular repair can be successfully achieved even in patients with a moderately hypoplastic LV (z score < -3). Following successful biventricular repair, the MV annulus, LV dimensions, and aortic valve annulus size all showed significant increases. Notably, preoperative MV size and pressure gradient across the ASD were inversely correlated with postoperative MV growth. Patients with a low preoperative ASD pressure gradient experienced a significant increase in MV size after biventricular repair despite having very small initial MV z scores.

A high ASD pressure gradient—reflecting elevated left atrial pressure in the setting of a restrictive or intact atrial septum—serves as a "natural functional stress test" for the growth potential of the left heart. In the absence of intrinsic MV pathologies (such as a parachute MV, which was excluded from this study), high atrial pressure combined with a persistently small valve suggests LV noncompliance and potential recruitment failure. These findings underscore the importance of ASD physiology in determining the feasibility of biventricular repair and offer a new lens through which clinicians can navigate the grey zone in patients with borderline hypoplastic left heart complex.

The results of this study also highlight the inherent limitations of conventional scoring systems, such as the Rhodes or CHSS scores, in the context of CoA/IAA. Unlike previous studies that reported high rates of biventricular repair failure in patients with MV z scores below -2.5, this

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cohort demonstrated that successful "catch-up" growth is achievable if the pressure gradient across the ASD physiology is not high. Furthermore, this study's findings align with the "no flow, no grow" theory but add a nuanced layer by demonstrating that ASD acts as a critical hemodynamic regulator by either facilitating or hindering the flow-dependent growth of the left heart structures.

Even when the initial morphometric scores favor single-ventricle palliation, the presence of a low-pressure left-to-right shunt at the atrial level may provide the necessary preload to support successful biventricular repair. Consequently, clinicians should prioritize assessing ASD hemodynamics as a functional indicator of LV growth, potentially expanding the criteria for biventricular repair in borderline candidates. By shifting the focus from purely anatomical measurements to hemodynamic indices such as the ASD pressure gradient and adopting a more integrated approach to surgical decision-making, clinicians may find that the "grey zone" of borderline hypoplastic left hearts is narrower than previously thought. Ultimately, refining these selection criteria is essential for improving the long-term outcomes of this vulnerable infant population.

See the article "Influence of atrial septal defect on mitral valve growth after repair of coarctation of the aorta or an interrupted aortic arch in infants" <https://doi.org/10.3345/cep.2025.02110>

Footnotes

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