Commentary: The Achilles' heel of the stage 1 palliation

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Disclosures: Author has nothing to disclose with regard to commercial support.

Received for publication April 9, 2019; accepted for publication April 9, 2019; available ahead of print May 31, 2019.

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J Thorac Cardiovasc Surg 2019;158:863-4

0022-5223/\$36.00

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<https://doi.org/10.1016/j.jtcvs.2019.04.007>

The basic tenets of the Norwood procedure remain constant; however, the operation itself continues to evolve. Technical refinements have greatly reduced the early issues with arch narrowing and anatomic coronary ischemia; however, the optimal method of pulmonary blood flow remains the Achilles' heel of the operation. After early attempts with a right ventricle-to-pulmonary artery (RV-PA) conduit,¹ the modified Blalock-Taussig shunt was adopted, which avoids any acute injury to the ventricle. Because of a number of geometric and hydrodynamic considerations, creating the optimal size shunt may be difficult, and the introduction of diastolic runoff may heighten the risk of coronary insufficiency and sudden death. The reintroduction of the RV-PA conduit into the neonatal palliation of hypoplastic left heart syndrome² has been reported to improve early survival³; its effects on right ventricular function and pulmonary artery growth, however, are still debated.^{4,5} The use of supported, nonvalved grafts placed through limited right ventricular incisions⁶ may help to reduce the injury to the ventricle and thus the need for postoperative interventions⁷; however, early conduit regurgitation with resultant ventricular volume loading and anastomotic distortion and bleeding may still be a concern.

In this issue of the *Journal*, Kumar and associates⁸ report their experience with the use of a femoral vein homograft (FVH) as an RV-PA conduit in a series of 24 consecutive patients undergoing neonatal palliation for single-ventricle lesions. Overall survival was excellent, and there was a low risk of significant postoperative bleeding. Because of the distensibility of the FVH, external banding with a polytetrafluoroethylene graft was required in 4 patients. Nearly two-thirds of the conduits maintained their competency at 1 month after the surgery, and 33% did so at 3 months. Although Kumar and associates⁸ report good overall growth of the pulmonary arteries, more than 50% of patients required catheter-based reinterventions, a finding quite similar to reports of various other techniques used to create RV-PA conduits.

Kumar and associates⁸ claim that the greatest advantages of the FVH as RV-PA conduit are the reduction in conduit

Optimal pulmonary blood flow is the Achilles' heel of the Norwood procedure.

Central Message

Results from the Norwood procedure continue to improve; the optimal source of pulmonary blood flow continues to elude us. Is femoral vein homograft another piece in the puzzle?

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insufficiency and consequent preservation of right ventricular function as well as the enhanced growth of the branch pulmonary arteries. Their technique for proximal anastomosis of the FVH to the right ventricle still involves a sizeable right ventricular incision and circumferential suturing to the myocardium; it is therefore tempting to attribute any improvement in right ventricular function to the reduction in conduit regurgitant volume. Unfortunately, the measurement of right ventricular function used by Kumar and associates⁸ was qualitative, and their findings are not remarkably different from those of other series. In addition, there was no quantification of the reduction in regurgitant volume. Finally, the results of Kumar and associates⁸ must be viewed in contradistinction to those of others who have shown no identifiable benefit from a valved conduit.⁹ The properties ascribed to the FVH conduit can certainly contribute favorably to outcomes after the Norwood procedure. To claim benefit on the basis of a reduction in conduit insufficiency, we must first document the extent of this insufficiency in nonvalved conduits and provide more scientific measurements of right ventricular function. At that point, the use of the FVH conduit, despite its need for banding and reintervention, or perhaps the implementation of other ways to limit conduit insufficiency, such as internal fluid diodes,¹⁰ can be championed.

References

1. Norwood SI, Lang P, Hansen DD. Physiologic repair of aortic atresia-hypoplastic left heart syndrome. *N Engl J Med*. 1983;308:23-6.

2. Sano S, Ishino K, Kawada M, Arai S, Kasahara S, Asai T, et al. Right ventricle–pulmonary artery shunt in first stage palliation of hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 2003;126:504-9; discussion 509-10.
3. Ohye RG, Sleeper LA, Mahony L, Newburger JW, Pearson GD, Lu M, et al; Pediatric Heart Network Investigators. Comparison of shunt types in the Norwood procedure for single-ventricle lesions. *N Engl J Med*. 2010;362:1980-92.
4. Newburger JW, Sleeper LA, Frommelt PC, Pearson GD, Mahle WT, Chen S, et al; Pediatric Heart Network Investigators. Transplantation-free survival and interventions at 3 years in the single ventricle reconstruction trial. *Circulation*. 2014;129:2013-20.
5. Raja SG, Atamanyuk I, Kostolny M, Tsang V. In hypoplastic left heart patients is Sano shunt compared with modified Blalock-Taussig shunt associated with deleterious effects on ventricular performance? *Interact Cardiovasc Thorac Surg*. 2010;10:620-3.
6. Tweddell JS, Mitchell ME, Woods RK, Spray TL, Quintessenza JA. Construction of the right ventricle-to-pulmonary artery conduit in the Norwood: the “dunk” technique. *Oper Tech Thorac Cardiovasc Surg*. 2012;17:81-98.
7. Bentham JR, Baird CW, Porras DP, Rathod RH, Marshall AC. A reinforced right-ventricle-to-pulmonary-artery conduit for the stage-1 Norwood procedure improves pulmonary artery growth. *J Thorac Cardiovasc Surg*. 2015;149:1502-8.e1.
8. Kumar TKS, Zurakowski D, Briceno-Medina M, Shah A, Sathanandam S, Allen J, et al. Experience of a single institution with femoral vein homograft as right ventricle to pulmonary artery conduit in stage 1 Norwood operation. *J Thorac Cardiovasc Surg*. 2019;158:853-62.e1.
9. Sandeep N, Punni R, Balasubramanian S, Smith SN, Reinhartz O, Zhang Y, et al. Interstage evaluation of homograft-valved right ventricle to pulmonary artery conduits for palliation of hypoplastic left heart syndrome. *J Thorac Cardiovasc Surg*. 2018;155:1747-55.e1.
10. Lane PA. An experimental study of the implementation of a fluid diode inside a Sano shunt. Department of Mechanical (and Materials) Engineering—Dissertation, Theses and Student Research. 2014. Available at: <http://digitalcommons.unl.edu/mechengdiss/87>. Accessed April 29, 2019.