

## Brief Report

# Use of a saphenous venous homograft for constructing a conduit from the right ventricle to the pulmonary arteries in the Norwood procedure

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**Abstract** The use of a conduit of polytetrafluoroethylene placed between the right ventricle and the pulmonary arteries as source of pulmonary arterial supply during the first stage of palliation for the hypoplastic left heart syndrome has facilitated post-operative management and resulted in decreased mortality. We describe here the use of a cryopreserved saphenous vein inserted in reversed direction to create the connection between the right ventricle and the pulmonary arteries in a neonate with low birth weight undergoing the modified Norwood procedure.

**Keywords:** Hypoplastic left heart syndrome; palliation; functionally single ventricle

**M**ANY CENTERS THAT CURRENTLY PERFORM first stage of palliation of patients with the hypoplastic left heart syndrome and aortic atresia have recently adopted a strategy that includes restoration of flow of blood to the lungs using a polytetrafluoroethylene conduit interposed between the systemic morphologically right ventricle and the confluence of the pulmonary arteries. We report here our experience with a small neonate in which continuity between these structures was restored with a homograft valved conduit, and speculate on the advantages of this particular implant.

### Case presentation

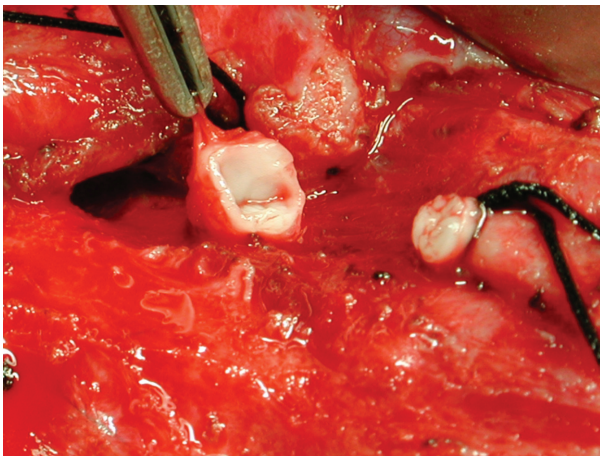
A male newborn, weighing 2.2 kg, was referred to our institution for staged surgical palliation of hypoplastic left heart syndrome. Pre-operative echocardiographic evaluation confirmed the diagnosis of severe mitral and aortic valvar hypoplasia, in presence of a non-apex-forming and fibroelastotic left ventricle, as

well as retrograde perfusion of the ascending aorta via the arterial duct. The patient underwent the first stage of Norwood palliation on the 9th day of life. Intra-operatively, the diminutive ascending aorta was augmented with a pulmonary arterial homograft patch, and a cryopreserved saphenous venous allograft of 4 mm diameter (Cryolife®, Kennesaw, Georgia, USA) was interposed between the right ventricle and the confluence of the pulmonary arteries. The periods of perfusion and ischemic arrest were, respectively, 97 and 53 min. The duration of profound hypothermic circulatory arrest was 40 min, at a nasopharyngeal temperature of 11°C. Following delayed primary sternal closure on the 2nd post-operative day, the hospital course was essentially uncomplicated.

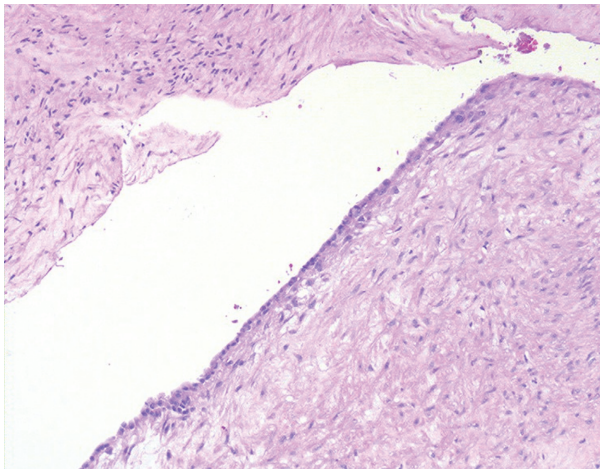
The infant presented for the second stage of palliation at 5 months of age. Pre-operative cardiac catheterization demonstrated a right ventricular systolic blood pressure of 73 mmHg, and mild stenosis of the distal end of the saphenous venous graft. Mean pressures in the right and left pulmonary arteries were 13 mmHg, with no evidence of distortion. At catheterization the ratio of pulmonary to systemic flow was calculated at 0.83:1, and the aortic oxygen saturation was measured at 74%. Echocardiographic examination revealed well-preserved right ventricular function, as well as absence of significant atrioventricular valvar

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**Figure 1.**  
Intra-operative photograph taken during construction of the superior cavo-pulmonary connection, as viewed from the patient's right side. Transection of the graft has revealed a macroscopically normal saphenous vein (held by forceps).



**Figure 2.**  
Histomicrophotograph of the explanted segment of the cryopreserved saphenous venous graft used for the conduit. There is a relative paucity of inflammatory cells, and the endothelium is intact (hematoxylin and eosin, 400 $\times$ ).

regurgitation. The patient underwent a superior cavo-pulmonary anastomosis on 5 September 2003. During the procedure, the saphenous venous homograft was transected (Fig. 1), and both proximal and distal anastomoses were left undisturbed. Again, the post-operative course was uneventful, and the infant was discharged home on the 4th post-operative day, with systemic saturations of oxygen of 79% in room air. Histologic examination of the graft (Fig. 2) showed lack of inflammatory cells and an intact endothelium. The patient is currently awaiting completion of the total cavo-pulmonary connection.

## Comment

Staged palliation of patients with hypoplasia of the left heart has undergone several modifications since its original introduction by Norwood et al. in 1983.<sup>1</sup> Among the different modifications, one of the most significant has been the substitution of the systemic-to-pulmonary shunt with the interposition of a polyfluorotetraethylene conduit between the right ventricle and the pulmonary arteries. Although this variation in technique was originally described by Norwood, Sano and other authors<sup>2,3</sup> have recently demonstrated the superiority of this approach in comparison to the modified Blalock–Taussig shunt, emphasizing the improved post-operative hemodynamic stability, early survival, and inter-stage attrition. Furthermore, comparable effects have been reported in the intermediate term in terms of myocardial function, ventricular diameter, tricuspid competence, pulmonary pressures, and regurgitant flow in the conduit.<sup>4</sup> As suggested by Murakami et al.,<sup>5</sup> the interposition of a valved saphenous venous graft may be of further benefit by limiting the effect of pressure and volume overload on the right ventricle. Mean ratios of reversal of flow in the conduit as low as 0.16 at 4 months post-operatively have been reported,<sup>2</sup> nonetheless, suggesting that the benefit of a competent valve in the circuit is likely to be limited to the early post-operative period.

Others have used saphenous venous grafts to construct systemic-to-pulmonary arterial shunts.<sup>6,7</sup> Those authors pointed out several advantages of a cryopreserved homograft vein when compared to polyfluorotetraethylene. Lack of thrombogenicity, amenability to banding, better hemostasis, and resistance to infection appear to offset the expense and the limited availability of the allograft. We believe these advantages to be of particular significance in low birth weight infants undergoing palliation of the functionally univentricular circulation. With reference to our own patient, a cryopreserved homograft vein of 4 mm external diameter will have an internal diameter of approximately 3 mm, an ideal size when used as a conduit for neonates weighing less than 3 kg. Given the limited time interval between initial palliation and the cavo-pulmonary anastomosis, stenosis due to degenerative changes is unlikely to occur, and aneurysmal dilation of the conduit has not been reported subsequent to its insertion in the systemic-to-pulmonary position.

Allograft thromboresistance may serve to further reduce attrition between the stages of Norwood palliation,<sup>8</sup> already substantially lowered by the introduction of the conduit placed from the right ventricle to the pulmonary arteries. In the experience reported by Sano et al.,<sup>2</sup> thrombosis of a shunt made

of polyfluorotetraethylene was still responsible for about one-tenth of the deaths occurring between the initial palliation and construction of the superior cavo-pulmonary anastomosis. We observed scarce inflammatory cells and intact endothelium in the explanted segment of our saphenous venous allograft, and speculate that this might be the histologic substrate for the lack of thrombogenicity associated with this conduit.<sup>7</sup>

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