

Second stage after initial hybrid palliation for hypoplastic left heart syndrome: Arterial or venous shunt?

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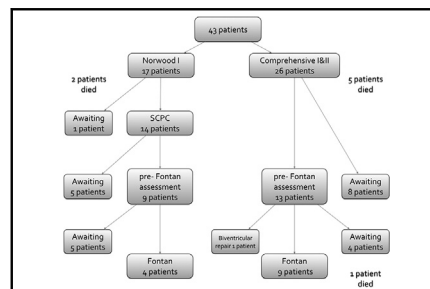
ABSTRACT

Objective: Hybrid palliation for hypoplastic left heart syndrome has been developed as an alternative to neonatal Norwood surgery. At the second stage, a source of pulmonary blood flow has to be established. Options include an arterial modified Blalock–Taussig or a venous superior cavopulmonary shunt.

Methods: We retrospectively reviewed patients who received second-stage palliation after the initial hybrid. Patients were stratified according to the source of pulmonary blood supply into the arterial shunt (n = 17 patients) or venous shunt (n = 26 patients).

Results: Age and weight at second stage were lower in the arterial group (85 [45–268] days vs 152.5 [61–496] days, *P* = .001 and 3.6 [2.7–9.4] kg vs 5.1 [2.97–9.4] kg, *P* = .001, respectively). All recorded surgical times were shorter in the arterial group. Mechanical ventilation and intensive care stay were shorter in the venous group (5.82 [2.01–14.9] days vs 2.42 [0.56–13.67] days, *P* = .005 and 8.5 [3.6–23.7] vs 5.75 [0.8–17.6] days, *P* = .036, respectively) There was no difference in mortality (2/17 vs 5/26; *P* = .685) or incidence of complications between the 2 groups. There was a tendency toward a higher need for intervention in the immediate postoperative period in the venous group, but this did not reach significance (6/17 vs 13/26, *P* = .342). The arterial group has shown better development of the branch pulmonary arteries with a higher lower lobe index (158.38 ± 39.43 mm²/m² vs 113.33 ± 43.96 mm²/m², respectively, *P* = .037).

Conclusions: Both arterial and venous shunts are viable options with mortality and morbidity results comparable to those in the literature. The arterial shunt pathway (2-stage Norwood I) may offer better pulmonary arterial growth than the venous shunt (comprehensive/combined Norwood I and II). (J Thorac Cardiovasc Surg 2015;150:350-7)



Schematic representation of overall outcomes of patients.

Central Message

This observational study show that a 2-stage Norwood I seems to be noninferior to a comprehensive Norwood I and II and may give better pulmonary arterial growth.

Perspective

Hybrid palliation for hypoplastic left heart syndrome is a relatively new technique. Our results have shown that a 2-stage Norwood I is a valid option compared with the comprehensive Norwood II. Over the years, we have developed criteria that can help to define which patient would benefit from a 2-stage Norwood I.

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Originally described to reduce the risk of neonatal surgery, hybrid palliation for hypoplastic left heart syndrome (HLHS) has been introduced as an alternative to the Norwood procedure, aiming to defer a more complex surgery to a later date with an older child who can withstand major operation with relatively lower risk.¹ Since 2005, it has been our institutional policy to use the hybrid operation in patients with HLHS presenting with low birth weight (<2.5 kg), postnatal collapse, restrictive atrial septum, or possible biventricular repair. The second stage after the initial hybrid involves construction of the aortic arch with establishment of pulmonary blood supply. A superior cavopulmonary anastomosis has been the pulmonary blood flow source of choice for this (ie, combined/comprehensive I and II as the second procedure), thus avoiding the transition from an arterial to a venous shunt seen in the traditional Norwood pathway.²

Abbreviations and Acronyms

AVV	=	atrioventricular valve
HLHS	=	hypoplastic left heart syndrome
MRI	=	magnetic resonance imaging
PA	=	pulmonary artery
POD	=	postoperative day
RPA	=	right pulmonary artery
SCPC	=	superior cavopulmonary connection

Concerns have been raised regarding this approach considering the significant challenge in the reconstruction of the pulmonary arteries (PAs) at the second stage after initial hybrid palliation.³ In addition, reports have shown lower branch PA size in the hybrid pathway compared with the Norwood pathway.⁴ Some centers have reported their experience with initial PA banding and duct patency maintenance with prostaglandin infusion followed by the Norwood I intervention, the so-called rapid 2-stage Norwood operation, for high-risk patients.⁵⁻⁷ Others have shifted their practice from a venous type of shunt to an arterial shunt after initial banding and maintenance of duct patency.^{8,9} We currently have a mixed practice of arterial or venous shunt. We reserve the arterial shunt simply because of the surgeon's preference or for those patients with suspected increased pulmonary vascular resistance, such as those developing a restrictive interatrial septum; those presenting with an indication for an early second stage, such as tight bands or retrograde coarctation; those with anomalous pulmonary venous drainage, in whom intervention on the superior vena cava or longer complex procedure is anticipated; those in whom better development of branch PA is required, as with hypoplastic PAs or interrupted IVC; and those who require a bail out of a high-pressure cavopulmonary anastomosis. On the other hand, in the absence of any of the previous indications, we tend to allocate all other patients, especially those with aberrant subclavian artery, to a venous type of shunt. In the current study, we compare these 2 cohorts of patients in terms of second-stage results, morbidity, mortality, and candidacy for Fontan completion.

MATERIALS AND METHODS

This is a retrospective study of a single institution. After institutional review board approval, the department database (Heartsuite XP 3.9.14, Systera, Glasgow, UK) was used to identify patients who reached the second-stage palliation after an initial hybrid between the start of the program in November 2005 and November 2014. Those who underwent biventricular repair, before the second stage, were excluded. Patients were divided into 2 groups according to the source of pulmonary blood flow: Group A received a systemic modified Blalock-Taussig shunt, and group B received a venous hemi-Fontan shunt. Not all patients were preassigned to either group at the time of hybrid. Postoperatively, patients received brain magnetic resonance imaging (MRI) or screening of vocal cords only if clinically indicated.

SURGICAL TECHNIQUE

We have previously reported our surgical technique for hybrid and arch reconstruction.^{10,11} At the time of the second-stage palliation, an arterial or venous shunt is constructed as the source of pulmonary blood flow. The arterial shunt is usually constructed between the first branch of the arch and the right pulmonary artery (RPA), and the venous shunt is a hemi-Fontan type of superior cavopulmonary anastomosis constructed in most cases under a period of total circulatory arrest. The ductal stent is usually peeled off the descending aorta after resection of the isthmus. In patients in whom the stent has been in place for a long time, the part of the descending aorta with the embedded stent is usually resected. The Sano-type right ventricle to PA shunt was not performed in any patients because of the institutional preference to avoid ventriculotomy of the systemic ventricle.

We tend not to patch the site of banding because of the friable nature of tissue. Instead, we free all adventitial bands and stretch the vessel from within. Patch material (a pulmonary homograft patch) is used only if the arterial wall is injured while breaking adhesions or the band has been in place for a long time and stretching was insufficient to dilate the constriction point. The PA stump is usually closed directly, and in a few cases, a small patch is used to close the stump to avoid branch PA distortion.

At the time of Fontan completion, a 4-mm fenestrated lateral tunnel Fontan is constructed. Any additional intervention on the atrioventricular valve (AVV), arch, or branch PA was recorded.

ASSESSMENT OF VENTRICULAR AND ATRIOVENTRICULAR VALVE FUNCTION

Patient records were reviewed. Echocardiographic qualitative assessments of ventricular function and degree of AVV regurgitation before operation and hospital discharge were recorded. For comparison, ventricular function was graded as 1 for normal/mildly depressed, 2 for mild-moderate/moderately depressed, and 3 for moderate-severe/severely depressed. AVV regurgitation was graded as 1 for trivial/mild, 2 for mild-moderate/moderate, and 3 for moderate-severe/severe regurgitation.

PRE-FONTAN ASSESSMENT

Currently, MRI is our investigation of choice for single ventricle palliation.¹² Our MRI technique has been reported.¹⁰ The following data were recorded:

1. Indexed lower lobe area of RPA and left pulmonary artery (LPA), because the lower lobe index was used to compare branch PA growth between the 2 groups.
2. Differential flow between both branch PAs.
3. PA pressure (measured through a superior vena cava line at the time of MRI).

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