

The innominate artery-to-pulmonary artery shunt as ventricular assist device outflow in hybrid stage one procedure with aortic coarctation



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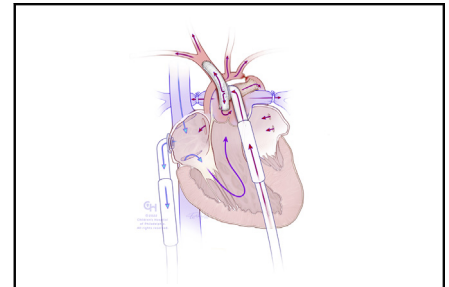
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VAD cannulation with outflow going to a shunt to bypass aortic arch obstruction.

CENTRAL MESSAGE

An innominate artery-to-pulmonary artery shunt can serve as VAD outflow in patients after hybrid stage one palliation to bypass aortic coarctation.

In a single-ventricle neonate with poor ventricular function, a ventricular assist device (VAD) implant at the time of, or after hybrid palliation, as a bridge to transplantation has been described. In this strategy, the outflow cannula is typically placed onto the main pulmonary trunk or the ascending aorta.¹ Although this strategy has been used successfully, in a case with hypoplastic arch or coarctation, delivering adequate VAD output to both the upper and lower body by one outflow cannula is challenging. Coronary or cerebral malperfusion may result if the outflow is placed on the pulmonary trunk and lower body malperfusion may result from ascending aortic outflow placement.

In this difficult setting, there are limited options to mitigate arch obstruction and thus ensure adequate VAD outflow. Stenting the aortic isthmus has been attempted but is technically difficult in the setting of a large ductal stent. Furthermore, this stent may disrupt the aortic wall, complicating later arch reconstruction, and long-term patency has yet to be determined. Continuous prostaglandin administration has also been used but is likely ineffective at maintaining patency of nonductal tissue in the aortic isthmus. Surgical revision of the coarctation has been described as effective² but is a major surgical undertaking that may not be tolerated in a patient with marginal physiology.

This report describes the successful use of an innominate artery-to-pulmonary artery shunt for VAD outflow in a patient with severe aortic coarctation. This technique successfully bypassed the coarctation, resulting in equalization of perfusion pressures throughout the cerebral, coronary, and systemic circulations with one VAD outflow.

CASE REPORT

The patient was born full term at 2.7 kg with a prenatal diagnosis of Turner syndrome and small left-sided cardiac structures with inadequate left ventricle size (for a 2-ventricle circulation) and severe transverse arch hypoplasia. Due to depressed cardiac function and severe lymphatic abnormalities seen on magnetic resonance lymphangiogram, she initially underwent hybrid palliation consisting of bilateral pulmonary artery bands and a 9 × 20-mm vascular stent placed into the ductus arteriosus on day of life 5. Her postoperative course was complicated by necrotizing enterocolitis, worsening right ventricular function, and the development of moderate tricuspid regurgitation. Therefore, she was listed for cardiac transplantation. While waiting, she suffered an acute decompensation requiring intubation and inotropic support and ultimately placement of a VAD at age 6 months to improve her transplant candidacy.

Preoperatively, she was found to have a 25- to 35-mm Hg gradient between the right arm and leg and echocardiogram demonstrated isthmus narrowing to 1.5 mm. Out of concern for inadequate upper and lower body perfusion, we elected

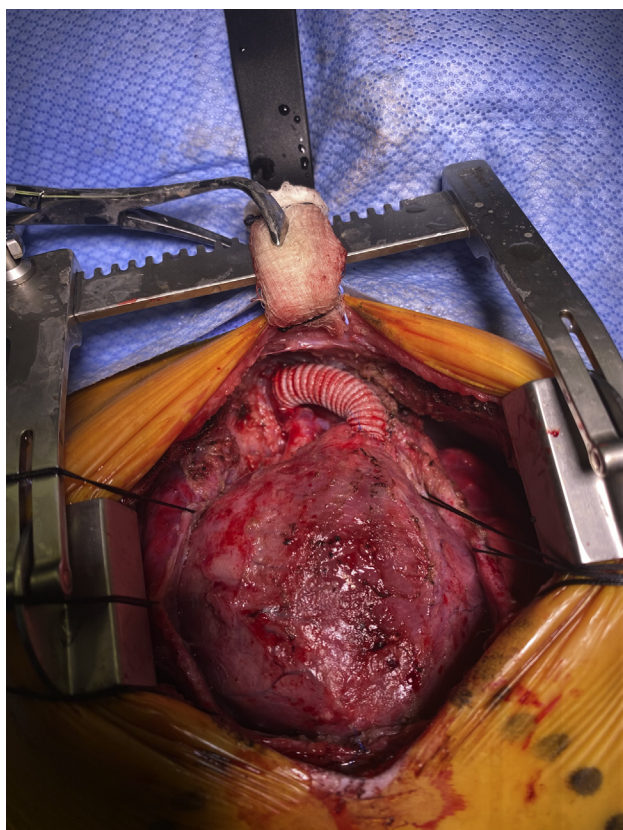


FIGURE 1. Intraoperative photograph demonstrating the placement of the innominate artery-to-main pulmonary artery shunt.

to place a shunt from the right innominate artery to the pulmonary trunk using a 10-mm Gelweave (Terumo Cardiovascular Group) graft (Figure 1). Following shunt placement, there was no residual gradient, and all saturations were equivalent. A 5-mm Berlin Heart (Berlin Heart) outflow cannula was then sewn to this shunt. A 6-mm Berlin Heart cannula was then sewn to the right atrium (Figure 2). The cannulae were tunneled and connected to a 10-mL pump. This procedure was performed without the use of cardiopulmonary bypass.

The patient recovered well with good end-organ function. She was weaned from ventilatory support, remained without any significant coarctation gradient, and was supported with this VAD for 119 days before undergoing successful cardiac transplantation. Neither informed consent nor institutional review board approval was obtained for this case report because neither is required for a case report per institutional guidelines.

DISCUSSION

This case demonstrates a novel VAD implant technique in a single-ventricle patient with poor ventricular function and severe coarctation after hybrid palliation. The innominate artery-to-pulmonary artery shunt bypasses aortic

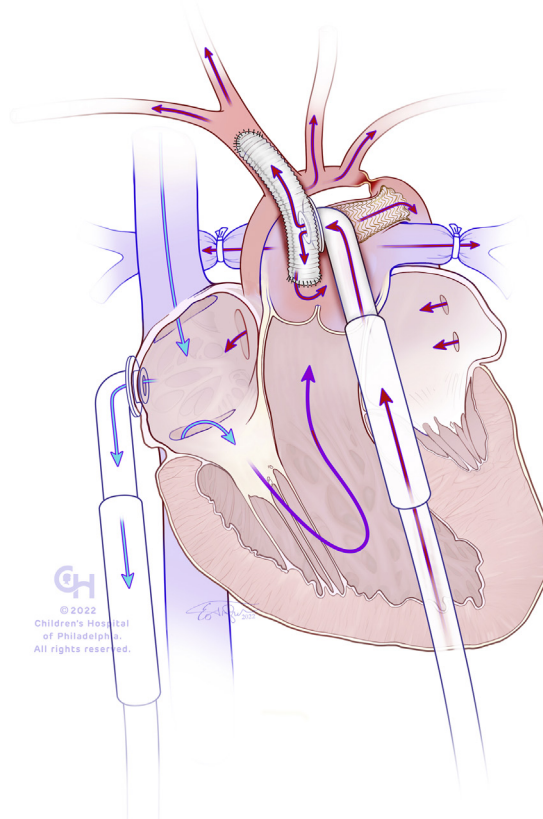


FIGURE 2. Illustration depicting the final cannula placement for the ventricular assist device, with common atrial inflow cannula and innominate artery to main pulmonary artery shunt outflow. Note the presence pulmonary artery bands, ductal stent, and narrowing of the aortic isthmus.

coarctation and allows for equalization of flow and pressure to systemic, cerebral, and coronary circulations. Having this shunt serve as the VAD outflow allows for uniform corporeal perfusion and eliminates the potential for coronary or cerebral ischemia without additional grafts or anastomoses.

Furthermore, this graft can be cannulated easily for cardiopulmonary bypass at the time of cardiac transplantation. During cardiectomy, the graft can be ligated and divided at its pulmonary artery anastomosis and can be used for selective antegrade cerebral perfusion during arch reconstruction and for total body perfusion following arch reconstruction. Because this shunt will not grow, this technique will likely be of greatest use in patients being bridged to transplantation. With increasing use of the hybrid procedure and its potential for reverse coarctation, we expect additional patients who may benefit from this novel technique for VAD implant.

The illustration was created for this article by Eo Trueblood and Stream Studios, Philadelphia, PA.

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