Use of Berlin Heart ventricular assist devices as a total artificial heart

Hideyuki Kato, MD, PhD, and Sanjiv K. Gandhi, MD, Vancouver, British Columbia, Canada

From the Division of Pediatric Cardiovascular and Thoracic Surgery, BC Children's Hospital, Vancouver, British Columbia, Canada.

Disclosures: Authors have nothing to disclose with regard to commercial support.

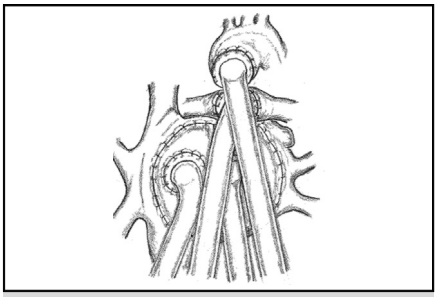
Received for publication Nov 28, 2017; revisions received Jan 25, 2018; accepted for publication March 4, 2018.

Address for reprints: Hideyuki Kato, MD, PhD, Division of Pediatric Cardiovascular and Thoracic Surgery, BC Children's Hospital, 4480 Oak St, Suite AB307, Vancouver, British Columbia, Canada V6H 3V4 (E-mail: hideyuki.kato@cw.bc.ca).

J Thorac Cardiovasc Surg 2018;■:1-3

0022-5223/$36.00

https://doi.org/10.1016/j.jtcvs.2018.03.005



Biventricular assist device insertion as a total artificial heart.

Central Message

Anatomic challenges in patients with single-ventricle anatomy mandated cardiectomy and biventricular VAD use as a successful bridge to transplant. This can be an option in select clinical situations.

Pediatric use of the Berlin Heart EXCOR (BH; Berlin Heart GmbH, Berlin, Germany) ventricular assist device (VAD) as a bridge to transplant (BTT) is commonplace.[1] We describe a surgical technique that may overcome certain technical challenges.

BH VAD use in patients with single-ventricle physiology has been limited.[2] The results are poor after stage I Norwood palliation. Single VAD support requires balancing the systemic and pulmonary circulations and is associated

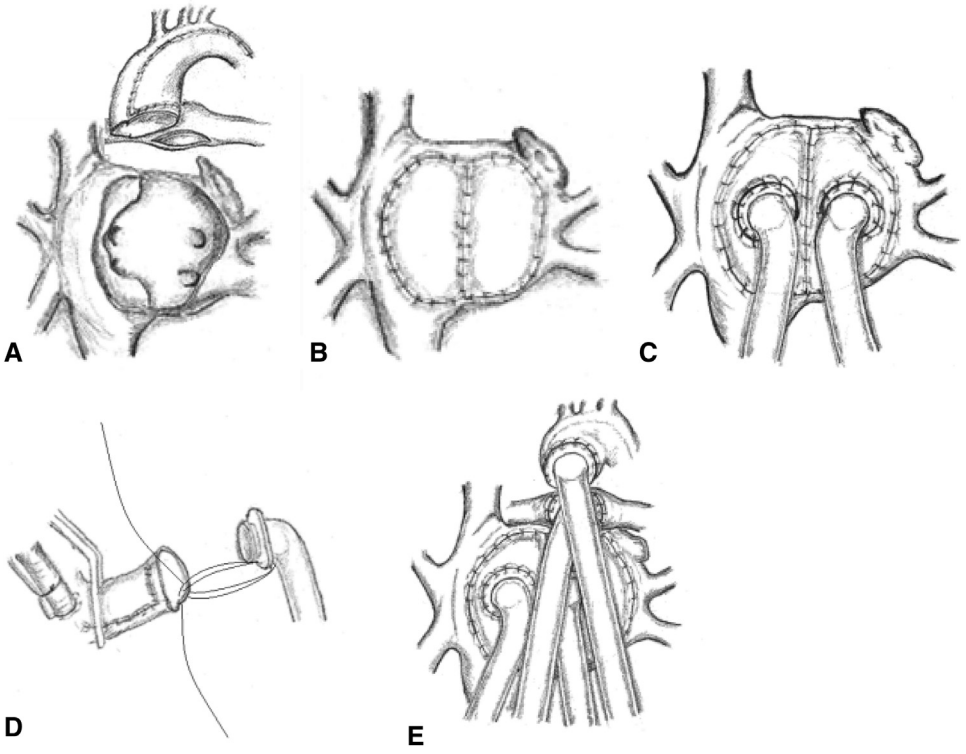


FIGURE 1. Cardiectomy and BiVAD insertion technique. A, After cardiectomy, with cuffs left of atria, neoaorta, and main pulmonary artery. B, Atrial cavity reconstruction with bovine pericardial patches. C, Atrial cannulation. D, Arterial cannulation. E, After BiVAD insertion.

with increased complications.[3] Support with biventricular assist device (BiVAD) placement mirrors normal cardiovascular physiology. Technical challenges relate to small thoracic capacity and enlarged cardiac size. Explantation of the native heart allows the use of BiVADs as a total artificial heart (TAH).[4] We report the cases of 2 infants successfully supported to heart transplantation (HT) after cardiectomy and BH BiVAD placement.

TAH SURGICAL TECHNIQUE

Cardiopulmonary bypass was initiated with aortic and neoaortic and bicaval cannulation. Cardiectomy was performed, leaving cuffs of ascending aorta, main pulmonary artery, and posterior right and left atria. After resection of the atrial septum to equalize atrial size, the atria were reconstructed with bovine pericardium (Figure 1, *A* and *B*). Two 6-mm atrial cannulas were shortened, and new tip side holes were created to optimize venous drainage. These modified cannulas were sewn to openings made in the atrial patches (Figure 1, *C*). Two 6-mm arterial cannulas were then anastomosed end to end to both the aorta and the pulmonary artery (Figure 1, *D*). All cannulas were tunneled, and 10-mL left and right VAD blood pumps were attached (Figure 1, *E*). The pumps were run separately. Rates were set with the left VAD greater than the right VAD by 5 beats and to achieve a cardiac index of at least 3 L/min/m^2.

CLINICAL SUMMARIES

Case 1

A female neonate had severe mitral stenosis and aortic atresia diagnosed. Echocardiography and cardiac catheterization demonstrated normal right ventricular function and coronary sinusoids without coronary stenoses (Figure 2, *A*, *B*, and *C*). An uneventful Norwood-Sano procedure was performed at 5 days. The patient was separated from bypass with robust hemodynamics. Several hours postoperatively, she had low cardiac output and was placed on extracorporeal membrane oxygenation support. Attempts at weaning from extracorporeal membrane oxygenation support were unsuccessful because of unmanageable sinusoidal runoff, manifested by low diastolic blood pressures. The patient was transitioned to BH TAH on postoperative day 8 as a BTT (Figure 2, *D*). Her clinical condition improved. After 6 days of TAH support, while preparing for extubation, a suitable donor was identified, and the patient underwent HT.

HT was complicated by primary graft dysfunction requiring extracorporeal membrane oxygenation support for 6 days and a severe acute kidney injury after the initiation of tacrolimus. The patient died 18 days after HT.

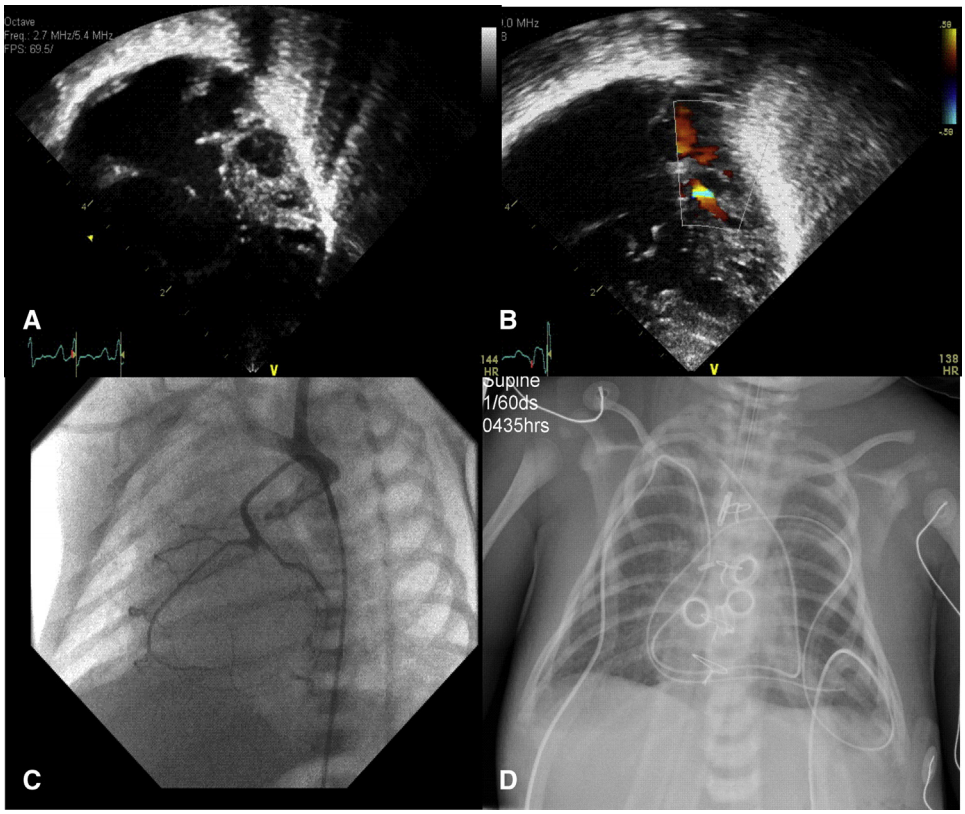


FIGURE 2. Case 1 preoperative and postoperative images. A, Preoperative transthoracic echocardiography. B, Preoperative transthoracic echocardiography with color Doppler (color shows large sinusoidal communication). C, Preoperative angiography. D, Postoperative chest radiography.