Novel strategy for postcardiotomy support in a patient with adult congenital heart disease

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CENTRAL MESSAGE
Unique case where preoperative planning with 3D printing of complex intracardiac anatomy facilitated accurate trans-right axillary placement of a single-ventricle Impella device (Abiomed Inc) for postcardiotomy support.

Since its introduction into clinical practice, the Impella 5.5 device (Abiomed Inc) has been used for cardiogenic shock in acquired heart disease as a bridge to recovery, definitive left ventricular assist device (LVAD) placement, or to transplantation. However, its use for postcardiotomy support in adult patients with complex congenital heart disease (ACHD) undergoing reoperative cardiac surgery, has yet to be described. We report such a case requiring special planning to facilitate satisfactory placement of an Impella 5.5 device.

METHODS AND RESULT

Institutional review board approval (00.017.861) was obtained June 11, 2021, for the study protocol and publication of data. The patient provided informed written consent for the publication of the study data.

A 26-year-old man with complex congenital heart disease (tricuspid atresia, malposed great vessels, and ventricular septal defect) palliated with a modified Damus-Kaye-Stansel operation and subsequent fenestrated lateral tunnel Fontan operation presented with severe pulmonary valve regurgitation (systemic semilunar valve) and severely reduced systemic LV function (ejection fraction, 30%).

For his severe semilunar valve regurgitation, he underwent a third-time surgical planning with 3D printing of complex anatomy, in particular to determine the intracardiac path of device placement. To facilitate planning of Impella 5.5 device placement in complex anatomy, in particular to determine the intracardiac path of the device, we performed 3-dimensional [3D] printing of a cardiac model based on radiological imaging (Figure 1). This 3D model allowed presurgical planning for advancement of the Impella 5.5 device to traverse the right axillary and brachiocephalic arteries, the ascending aorta, the native aortic valve, the rudimentary right ventricle, bulboventricular foramen, and its final placement in the center of the dilated LV cavity for an Impella length 5.5 cm (Figure 2). This was reproduced intraoperatively by anastomosing a beveled 8-mm Gelweave graft (Terumo Medical Corporation) to the right axillary artery exposed by a lateral infracavicular incision and division of the pectoralis major and minor muscles, then advancing an AL-1 catheter (Terumo Medical Corporation) backloaded with a 0.035 J-Wire (Terumo Medical Corporation) under fluoroscopic guidance, into the LV cavity, and then changeover of these with an 0.018 Impella wire. Due to the direct approach required for accurate device placement, the initial guidewire was directed through the native aortic valve and rudimentary right ventricle and Bulboventricular foramen into the LV cavity. Following valve replacement and closure of aortotomy, the aortic of first consideration was assessment of the patient’s vascular anatomy, which in this case consisted of preoperative computed tomography scanning, confirming the presence of a patent right axillary artery measuring 7 mm in diameter, and therefore of adequate size to facilitate Impella 5.5 device placement. To facilitate planning of Impella 5.5 device placement in complex anatomy, in particular to determine the intracardiac path of the device, we performed 3-dimensional [3D] printing of a cardiac model based on radiological imaging (Figure 1). This 3D model allowed presurgical planning for advancement of the Impella 5.5 device to traverse the right axillary and brachiocephalic arteries, the ascending aorta, the native aortic valve, the rudimentary right ventricle, bulboventricular foramen, and its final placement in the center of the dilated LV cavity for an Impella length 5.5 cm (Figure 2). This was reproduced intraoperatively by anastomosing a beveled 8-mm Gelweave graft (Terumo Medical Corporation) to the right axillary artery exposed by a lateral infracavicular incision and division of the pectoralis major and minor muscles, then advancing an AL-1 catheter (Terumo Medical Corporation) backloaded with a 0.035 J-Wire (Terumo Medical Corporation) under fluoroscopic guidance, into the LV cavity, and then changeover of these with an 0.018 Impella wire. Due to the direct approach required for accurate device placement, the initial guidewire was directed through the native aortic valve and rudimentary right ventricle and Bulboventricular foramen into the LV cavity. Following valve replacement and closure of aortotomy, the aortic
clamp was removed. Under fluoroscopic guidance, the Impella 5.5 device was advanced over the 0.018-inch guidewire, and positioned appropriately in the LV as described above in our 3D model. Commencement of Impella 5.5 device support at 4.5 L/minute enabled successful weaning from CPB with epinephrine 0.05 μg/kg/minute.

**DISCUSSION**

Many patients with ACHD present requiring cardiac surgery, including valve replacements, in the face of severe systemic ventricular dysfunction and with history of multiple prior sternotomies. Although transplantation remains a good option for these patients, the paucity of suitable organs and the relative longevity of the patients vis-à-vis their cardiac allografts behooves contemplation of conventional cardiac surgery with mechanical circulatory support. Post-cardiotomy extracorporeal membrane oxygenation support is a strategy to facilitate high-risk cardiac surgery, thereby preventing high inotropic support and multiorgan dysfunction associated with these, with reasonable results.4 Although the Impella 5.5 device has been described as a valuable strategy for bridging cardiogenic shock before implantation of LVAD or transplantation, to our knowledge, Impella 5.5 device support has not routinely been utilized for postcardiotomy support in ACHD, and here we show success of this approach in a patient with complex congenital heart disease.

In this case, use of 3D printing facilitated accurate intracardiac placement of the Impella 5.5 device. Given the
complex intracardiac anatomical constraints described here, we adopted this approach to prevent placement of the device through the wrong valve, and its consequent malpositioning against the interventricular septum or the lateral LV wall. Misplacement of the device in complex anatomy such as is reported here could result in flow limitation and hemolysis.

CONCLUSIONS
Our report describes a unique case where careful preoperative planning with 3D printing of complex intracardiac anatomy facilitated accurate trans-right axillary placement of single-ventricle Impella 5.5 device for postcardiotomy support in complex ACHD.

References