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Hamed Al Kalbani, Charles Juvin, Guillaume Lebreton. Surgical technique for the implantation of mechanical circulatory support with the Impella 5.0 pump in a patient with post-cardiotomy cardiogenic shock. *Annals of Cardiothoracic Surgery*, 2021, 10 (2), pp.292 - 294. 10.21037/acs-2020-cfmcs-33 . hal-03197952

HAL Id: hal-03197952

<https://hal.sorbonne-universite.fr/hal-03197952>

Submitted on 14 Apr 2021

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Surgical technique for the implantation of mechanical circulatory support with the Impella 5.0 pump in a patient with post-cardiotomy cardiogenic shock

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Submitted Jan 14, 2021. Accepted for publication Mar 02, 2021.

doi: 10.21037/acs-2020-cfmcs-33

View this article at: <http://dx.doi.org/10.21037/acs-2020-cfmcs-33>

Clinical vignette

A fifty-one-year-old male with no significant medical history, presented with acute severe shortness of breath. Emergency echocardiogram revealed dilated cardiomyopathy and severe left ventricular dysfunction with an ejection fraction (EF) of 25–30%, and severe mitral regurgitation due to P2 cusp prolapse and ruptured chordae tendineae.

Given the patients' cardiogenic shock with severe refractory hypoxemia, veno-arterial extracorporeal membrane oxygenation (VA-ECMO) was implanted and inotrope support commenced. The patient underwent mitral valve repair and implantation of mechanical circulatory support Impella 5.0 pump (Abiomed, Danvers, MA, USA), for post-cardiotomy cardiogenic shock (PCCS).

The Impella was explanted on the ninth postoperative day. The patient stayed in the intensive care unit for 11 days, including 3 days after explantation, and was discharged home 14 days post-explant and 23 days postoperatively with an EF of 35–40%.

Surgical techniques

Before the procedure, a computed tomography (CT) scan or ultrasound imaging of the axillary artery is important to ensure the artery has a minimum caliber of 6.20 mm, which is necessary for the Impella 5.0 device's implantation (if <6.20 mm, Impella CP can be used). The procedure can be performed in a regular operating room, however a hybrid

operating room is preferred.

General anesthesia is induced. The patient is placed in supine positioning and a transesophageal echocardiography (TEE) probe introduced. A rolled sheet is placed under the left shoulder to properly expose the incision site.

A small transverse 5–7 centimeters skin incision is made approximately 2 centimeters inferior and parallel to the left clavicle. The clavipectoral fascia is opened. The pectoralis major muscle is split and retracted by a retractor.

Small vessel branches are clipped or ligated. Once the axillary artery is visualized, it is dissected and looped by two retraction tapes in order to facilitate its exposure. The patient is then heparinized for an activated clotting time (ACT) >250 seconds. The axillary artery is clamped with a vascular clamp and a longitudinal 15 mm incision is made. End-to-side anastomosis with an 8 mm Dacron graft is made using a running 6-0 prolene suture. After hemostasis is achieved, the graft is clamped and tunneled subcutaneously through a small incision 10 to 15 centimeters (to reduce the infectious risk) below the subclavian approach.

The Impella introducer kit is introduced on the distal part of the graft and secured with the graft lock. Using both TEE and fluoroscopy, a soft 0.035-inch guidewire is introduced and advanced into the left ventricle (LV). This guidewire is then exchanged with a 0.018-inch Impella guidewire using a pigtail catheter. Alternatively, the guidewire can be inserted in the LV before cross-clamping. Cross-clamping is then performed while the guide wire is left *in situ* to facilitate subsequent insertion of the Impella.

The Impella is then introduced and placed in the

transaortic valve position over the guidewire, under the control of both fluoroscopy and TEE, along with the positioning signal on the Impella monitor. The device is activated after removing the guidewire. The trimmed graft is secured around the catheter using a heavy silk tie and the two skin incisions are classically closed.

Comments

Why we recommend Impella over VA-ECMO for post-cardiotomy cardiogenic shock

PCCS occurs in 0.2–6% of patients undergoing coronary or valvular surgeries and is associated with high mortality rates of 50–80% (1). Over the last 50 years, VA-ECMO has been used to support patients with PCCS (2); however, from our experience, we recommend the use of Impella 5.0 over the use of VA-ECMO. VA-ECMO is not only invasive, but also associated with significant morbidity and poor quality of life (3). Impella 5.0 has proven itself an effective minimally invasive treatment option for critically ill patients with PCCS and is associated with favorable survival outcomes. Our department published a study in 2020 in which Impella was used to support 29 patients with PCCS. Of those 29, Impella was successfully weaned in 72.4%, and 58.6% survived to discharge, with 58.6% survival at 30-day and 51.7%, survival at 1-year (4).

Furthermore, Impella 5.0 was associated with recovery of native heart function in 100% of patients who survived to discharge because it provides effective hemodynamic support by achieving both LV unloading and systemic perfusion (3). This is in contrast to ECMO, which improves systemic perfusion without directly unloading the LV (5). The retrograde flow generated by VA-ECMO in the descending aorta, increases the afterload, thus resulting in LV distension and further impairing heart recovery. Furthermore, Impella 5.0 aids in transitioning off cardiopulmonary bypass (CPB), given the beneficial effect on hemodynamics (4).

In addition, while implantation of VA-ECMO via femoral cannulation often restricts mobility (6), axillary implantation of the Impella 5.0 allows early mobilization which contributes to improved survival outcomes (6).

Technical points during the implantation of Impella 5.0?

There are three key technical points that must be highlighted. First, the positioning of the Impella must be

properly placed in the transaortic valve position under the control of both fluoroscopy and TEE, along with the positioning signal on the Impella monitor.

Second, proper hemostasis must be achieved because of both ECMO-associated coagulopathy and the need for post-operative anticoagulation.

Third, during the weaning of CPB and transition to Impella, it is crucial to balance the flow support between the two. In order to manage this transition effectively, mechanical ventilation must be restarted, followed by a gradual decrease in CPB flow in order to fill the LV, thus providing a smooth change to Impella support.

What are further indications for Impella?

Although, Impella has often been used for patients with PCCS undergoing coronary or valvular surgeries with low EF (<25%), other indications include ventricular septal defect (VSD) and ruptured LV. In these settings, Impella support can provide improved catheterization and recovery of native heart function.

Which axillary artery for Impella implantation?

We recommend the use of the left axillary artery over the right axillary artery for Impella implantation for two main reasons. First, the shape and presentation of the device make it easier to direct and place in the transaortic position. Second, to avoid injury to the right carotid artery especially when removing the device.

Acknowledgments

Funding: None.

Footnote

Conflicts of Interest: GL received research grants and honoraria for lectures from Abiomed. The other authors have no conflicts of interest to declare.

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Cite this article as: Al Kalbani H, Juvin C, Lebreton G. Surgical technique for the implantation of mechanical circulatory support with the Impella 5.0 pump in a patient with post-cardiotomy cardiogenic shock. *Ann Cardiothorac Surg* 2021;10(2):292-294. doi:10.21037/acs-2020-cfmcs-33