Use of Impella CP Device in Off-Pump Coronary Artery Bypass Graft Surgery

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Summary

Off-pump coronary artery bypass grafting (OPCABG) may be performed on patients with high surgical risk who are poor candidates for traditional mechanical circulatory support. Hemodynamic support with micro-axial mechanical circulatory devices has been performed with limited but promising results.

We report a case of a 66-year-old male with multiple comorbidities and low cardiac output undergoing OPCABG. Impella CP device was deployed for “in-pump” support during surgical coronary revascularization resulting in intraoperative stability and uncomplicated post-operative recovery.

Previous reports have described the use of the Impella Recover LP 5.0 device for use during OPCABG. We describe the successful and safe perioperative use of the Impella CP device. Despite lower flow rates, adequate support was achieved and the transfemoral cannulation and smaller outer diameter than the Impella 5.0 device may decrease the risk of complications and expedite recovery. Further research will be necessary to determine the optimal perioperative hemodynamic support strategy to offer hemodynamically unstable, high, and prohibitive risk patients.

Key words: Hemodynamics, Circulation, Hemodynamic support, Cardiac catheterization

Case Report

A 66-year-old male with a past medical history of hypertension, hyperlipidemia, coronary artery disease, systolic heart failure with an ejection fraction of 25%, and a primary prevention biventricular ICD presented to outside...
facility with unstable angina and aborted sudden cardiac death. He had been treated with several rounds of anti-tachycardia pacing and at least six internal defibrillations. On arrival, he was amid incessant episodes of pace terminated ventricular tachycardia. He was started on intravenous amiodarone and transferred to the cardiac care unit at our hospital.

Peak troponin I level before arrival was 7.48 ng/mL, and under the circumstances, he was taken for emergent coronary angiography. We identified >90% calcified stenosis of proximal left anterior LAD, proximal right coronary artery, and ramus intermedius with moderate distal left main tapering. We also identified high-grade middle left anterior descending bifurcation stenosis involving the origin of the first diagonal (medina 0.1,1) (Figure). The anatomic Syntax score was 41 (high). His angina and arrhythmias became more quiescent with medical therapy and he recovered in the coronary care unit where the heart team was convened. On further workup, he was found to have a left ventricular ejection fraction of 25%-30%, moderate left ventricular dilatation, stage 3 chronic renal failure, and a heavily calcified ascending aorta. Considering his age of only 67 years, left ventricular systolic dysfunction, high anatomic Syntax score, and risk of acute renal failure with repeated contrast dye exposures, our team opted to offer off-label use of OPCABG, which the patient consented to.

He was brought back to the cardiac catheterization lab pre-operatively and an Impella CP device (Abiomed, Danvers, MA) was inserted via the right common femoral artery pre-operatively and an Impella CP device (Abiomed, Danvers, MA) was inserted via the right common femoral artery in the usual fashion. The Impella CP device that remained in place was used during the CABG operation as “in-pump” support, and a standard OPCABG was performed using a pedicle left internal mammary artery (LIMA), and reverse great saphenous vein (SVG) was endoscopically harvested. The LIMA was dissected out, and the distal targets were identified. The heart was elevated with moist lap pads taking care not to disrupt the Impella CP device. The target vessels were stabilized using an Octopus AS tissue stabilizer (Medtronic), and the distal anastomosis was completed. Three revascularization targets were achieved before hypotension began to progress (LIMA to the left anterior descending; SVG to the right coronary artery; SVG to the ramus intermedius). The diagonal artery was left for medical therapy. The two proximal aortic anastomoses were created using HEARTSTRING III proximal seal system (Getinge). The Impella CP device remained in place post-operatively, and the patient was taken back to the cardiac surgery intensive care unit. The Impella CP device was subsequently weaned and removed on post-operative day 3 in the cardiac catheterization lab and hemostasis obtained by tying down of Perclose Proglide (Abbott) sutures deployed at the time of the index procedure in the “preclose” technique. Completion ileo-femoral angiography acquired via the left radial artery demonstrated no vascular complication. The patient fared well and was transferred out of the intensive care using on post-operative day 5, where the remainder of his hospital stay was uneventful, and he was discharged on post-operative day 7.

Discussion

Contradictory evidence exists in comparison with complications and all-cause mortality in trials that involve off-pump CABG and conventional on-pump CABG. The meta-analyses performed have shown an increase in all-cause long-term mortality in patients with off-pump CABG compared with that with the traditional modality. In 2014, a meta-analysis of more than 20 studies found a statistically significant 7% increase in long-term all-cause mortality with off-pump relative to on-pump CABG. Conversely, in 2016, a meta-analysis of 100 studies found no difference between the two techniques when comparing myocardial infarctions and all-cause mortality. In 2018, a meta-analysis that comprised more than 8000 patients reported higher mortality in OPCABG than in on-pump CABG after 4 years or longer post-procedure. With the population-based evidence aside, each patient’s clinical circumstances warrant a personalized approach.

There exist alternative strategies to improve outcomes and reduce peri-operative complications in off-pump coronary artery bypass grafting. Minimally invasive strategies applied during off-pump CABG, such as minimally invasive direct CABG, have benefits including faster recovery and improved results. Percutaneous mechanical circulatory devices used during off-pump CABG may provide the additional circulatory support needed during the necessary intraoperative cardiac manipulations and anesthesia that decrease cardiac output. The use of Impella devices
has been previously described.\textsuperscript{14,15} Multiple cases have shown the utilization of the Impella 5.0 device during off-pump CABG.\textsuperscript{16,17} The Impella 5.0 device uses a 21 French pump motor with peak flow up to 5.0 L/minute.

The device used on our patient provides up to 3.5 L/minute of circulatory support. More importantly, the Impella CP device requires only the insertion of additional peripheral vascular access via a transfemoral approach with a lower profile system (Impella CP sheath outer diameter 17F; \(\sim 4.7 \text{ mm}\)) when compared with a higher profile and more invasive Impella Recover LP 5.0 system.

The novel use of the Impella CP device with a peak flow rate of 3.5 L/minute in our case provided appropriate circulatory support for optimal recovery. Using the smaller motor size (catheter max outer diameter 14F) along with decreased power requirement may lead to decreased complications that result from the use of Impella devices. The use of a smaller-sized pump may have decreased the incidence of valve dysfunction, thromboembolic complications, thrombosis, ventricular perforation, bleeding, and vascular complications.\textsuperscript{9} As this was an off-label use of the Impella device, caution should be taken before repeating our approach, and further research is required to advance this burgeoning multi-disciplinary field.

**Conclusion**

We report a novel strategy using an Impella CP device for perioperative hemodynamic support in a compromised patient undergoing high-risk off-pump CABG with no complication and rapid recovery. The use of the Impella CP device for patients undergoing off-pump CABG may improve outcomes, and further studies should be conducted to assess short- and long-term results in patients undergoing coronary revascularization through surgical means.

**Disclosure**

**Author contributions:** V.D.U., S.C., S.D., and I.P. visualization and writing-original draft, review, and editing. K.T.A. and M.D.S. writing-review and editing. All authors have read and agreed to the published version of the manuscript.

**Conflicts of interest:** The authors declare no conflict of interest.

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