Case Reports

Use of a Vascular Sheath in the Axillary Artery

as an Alternative Access Approach for Placing an Impella 5.0 Device

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Many patients who are in cardiogenic shock need mechanical support for clinical stabilization after acute insults such as myocardial infarction. However, the placement of advanced devices can be hindered by anatomic constraints or the physiologic sequelae of shock, as we describe in this report.

A 67-year-old woman with prior coronary artery bypass grafting and extensive chest-wall scarring from previous defibrillator implantations presented with myocardial infarction and refractory cardiogenic shock. The patient's vascular anatomy and prior surgery precluded conventional percutaneous implantation of an Impella 5.0 ventricular support device. We delivered the Impella device through the patient's tortuous, vasoconstricted axillary artery with use of a vascular sheath and other percutaneous techniques. The success of this approach suggests that combining the expertise of cardiologists and cardiovascular surgeons can improve the outcomes of patients with complex anatomic issues.
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Cardiogenic shock is a complex condition associated with a high mortality rate. Percutaneous mechanical support devices such as intra-aortic balloon pumps or the Impella® (ABIOMED, Inc.; Danvers, Mass) can help to stabilize some patients in shock who are refractory to medical therapy,[1-4] particularly during their recovery from an acute insult such as myocardial infarction. However, many patients in cardiogenic shock have substantial atherosclerosis or vasoconstriction that limits the arterial lumen available for device placement. Previous reports and the manufacturer's recommendations suggest Impella placement either through a sheath in the femoral artery or through a Dacron graft in the axillary artery without the use of a guiding sheath.[5,6] We describe a technique involving sequential dilations and a supportive sheath to advance an Impella® 5.0 percutaneously through a patient's tortuous, vasoconstricted axillary artery. This process of Impella placement illustrates how the combined expertise of cardiac surgeons and interventional cardiologists can lead to an improved procedural outcome.

Case Report

In autumn 2012, a 67-year-old woman with ischemic cardiomyopathy and a history of coronary artery bypass grafting and right- and left-sided implantable thoracic defibrillators was transferred to our hospital with myocardial infarction and cardiogenic shock. Despite aggressive inotropic and vasopressor support, she developed shock liver, renal failure, and worsening pulmonary edema. The results of cardiac catheterization revealed markedly elevated filling pressures, with a left ventricular end-diastolic pressure of 35 mmHg. Her cardiac output was markedly depressed at 3.5 L/min despite high doses of inotropic agents and vasopressors. Her coronary revascularization was adequate, with patent saphenous vein grafts to the left anterior descending and right coronary arteries; the left circumflex coronary artery was small and nondominant. Peripheral angiograms revealed small, vasoconstricted iliac and femoral arteries (Fig. 1). Given the patient's persistent cardiogenic shock despite inotropic support, an Impella® 2.5 device was placed percutaneously through a 14F sheath via the left femoral approach. This yielded modest improvement in her hemodynamic status and end-organ perfusion, with reductions in alanine transaminase levels from the 800s to the 400s U/L and some resumption of urine output. Vasopressors were gradually titrated downward.

Twelve hours later, the patient's left lower extremity became ischemic, with nonpalpable distal pulses and a cold left foot, necessitating Impella removal. She subsequently redeveloped cardiogenic shock, with increased levels of alanine transaminase to the mid-2,000s U/L and recurrent anuric renal failure. The patient's creatine kinase-MB fraction and cardiac troponin levels remained only mildly elevated. Given her initially favorable response to mechanical support, it was decided to proceed with more robust hemodynamic support: an Impella 5.0 device surgically placed in the upper extremity.

In the cardiac surgical operating room, the right axillary artery was exposed by means of a subclavicular approach. Visual comparison of 8- and 10-mm Dacron grafts with the small, severely vasoconstricted artery suggested that the smaller graft would be necessary for Impella insertion.[5] Accordingly, after proximal and distal control of the artery was achieved, the 8-mm Dacron graft was anastomosed to the axillary artery in end-to-side fashion. A standard 0.035-in guidewire was advanced, and fluoroscopy revealed that the anatomic course of the proximal axillary and subclavian arteries was highly tortuous. A 5F Judkins Right catheter was navigated across the aortic valve into the left ventricle, and a stiff 0.025-in peripheral guidewire was exchanged to facilitate Impella advancement. However, extensive attempts to maneuver the Impella through the graft into the axillary artery were unsuccessful.

At this point, we obtained a 30-cm-long, 20F peripheral sheath (Cook Medical, Inc.; Bloomington, Ind) to more easily deliver the Impella. On the sterile field, we found that the Impella could not pass through the diaphragm of the sheath but could be pushed in retrograde fashion through the main body of the 20F sheath. As a result, we performed sequential arterial dilations with 10F, 14F, and 18F dilators down to the level of the ascending aorta. We then advanced the 20F sheath and its dilator over an extra-stiff 0.035-in guidewire to the level of the aortic valve, removed the dilator, and cut the diaphragm and side port from the proximal segment of the sheath (Fig. 2). Aggressive manual compression was applied proximally to minimize hemorrhage, and the body of the 20F sheath was used as a conduit to straighten the upper-extremity arteries. The Impella 5.0 was advanced over the guidewire into the body of

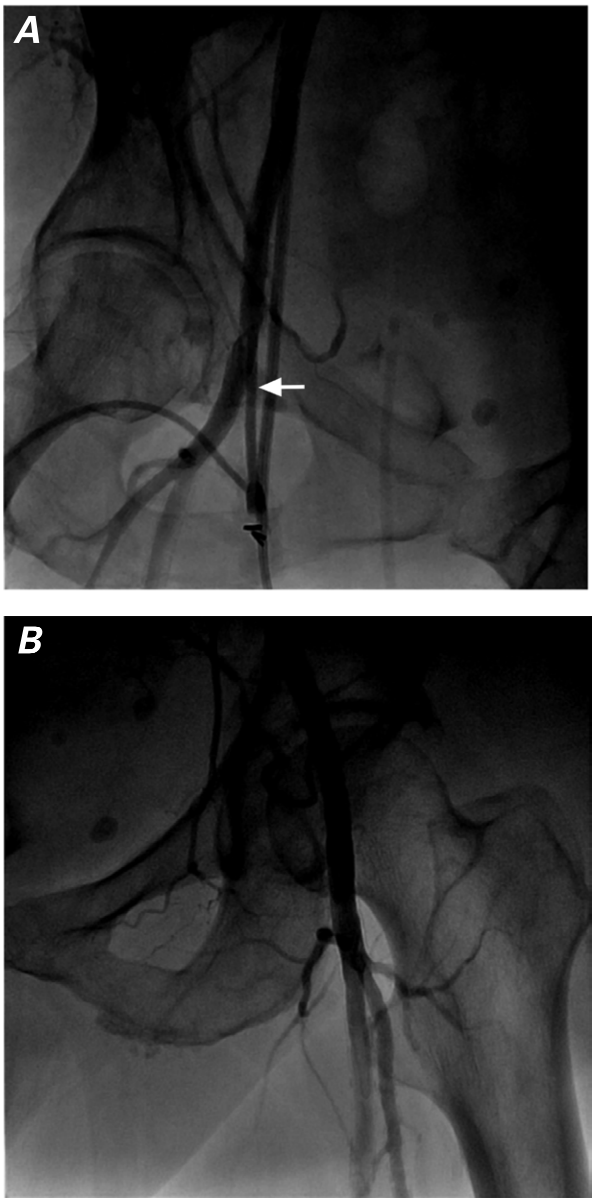

Fig. 1 ***A****) Diagnostic right iliofemoral angiogram shows a 6F sheath in the right common femoral artery (arrow).* ***B****) Upon left iliofemoral angiography, measurement of the right and left common femoral arterial diameters suggested that both sides would be too small and vasoconstricted to adequately accommodate a 14F sheath for prolonged Impella 2.5 placement.*

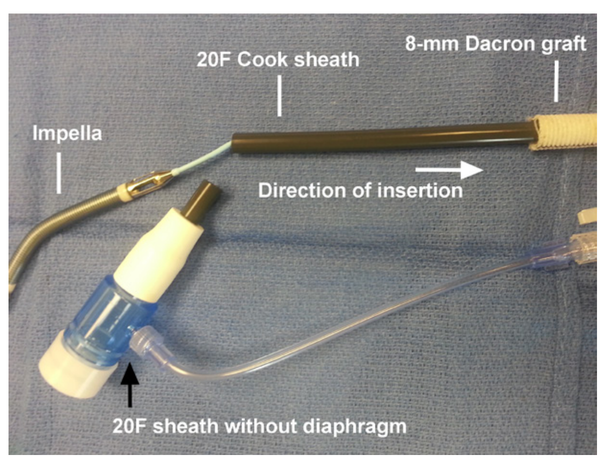

Fig. 2 *Photograph shows setup of the device delivering components. The Impella 5.0 was inserted through an 8-mm Dacron graft with use of the body of a 20F sheath (after removal of the sheath diaphragm).*

the sheath, through the graft and axillary and subclavian arteries, and finally across the aortic valve.

The body of the sheath was removed along with the guidewire, and the Dacron graft was clamped to achieve hemostasis. Placement of the Impella was confirmed with use of echocardiography, and excellent function was confirmed, with a cardiac output of 4.3 L/min on the P8 setting. The sheath was longitudinally incised and peeled off the external Impella tubing. The graft was trimmed to an appropriate length. A bulb suction drain was placed to drain the soft tissues, and the incision site was closed. When transported to the intensive care unit, the patient had good perfusion of the right forearm and hand. Impella placement from the upper extremity to the left ventricle was confirmed on chest radiographs (Fig. 3). Her hemodynamic status improved substantially over the next 24 hours; however, she developed several noncardiac complications and was transferred to hospice care several days later.

Discussion

The Impella 5.0 provides mechanical circulatory assistance in patients who are in cardiogenic shock.[5,6] In our patient, refractory cardiogenic shock necessitated mechanical support, although standard femoral and thoracic delivery routes were not feasible because of severe iliofemoral disease and extensive thoracic scarring.

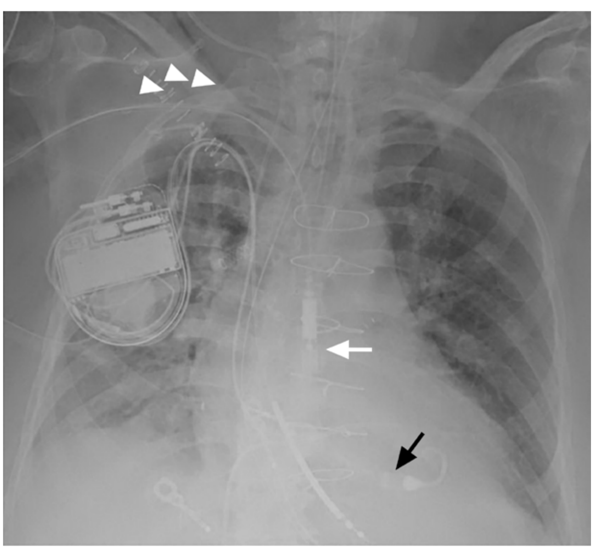

Fig. 3 *Chest radiograph confirms placement of the Impella 5.0 from the right upper extremity. The inflow cannula is in the left ventricle (black arrow), the outflow cannula is above the aortic valve in the ascending aorta (white arrow), and the Impella wires are externalized near the surgical staples in the right axillary artery (arrowheads). Note the evidence of pulmonary vascular congestion in the lung fields, and a right-sided defibrillator and associated wires, an endotracheal tube, a nasogastric tube, a right-neck central venous line, and sternotomy wires in the mid-chest.*

Although right axillary artery access was feasible, anatomic issues precluded Impella placement with use of standard techniques. We improvised by using a smaller Dacron graft and a smaller peripheral vascular sheath as delivery conduits.

Sassard and colleagues[5] described an alternative approach for placement of the Impella 5.0 via the right subclavian artery, and the manufacturer has recommended axillary access with use of a Dacron graft.[6] However, to date, no techniques have been documented for axillary or subclavian Impella placement in individuals who have difficult vascular anatomy of the upper extremity. A ministernotomy approach has been described for individuals with small arteries; however, this requires a more invasive procedure with pericardial exposure and might not be safe in repeat thoracic surgical situations, as in our patient.

This report has several important implications for the treatment of patients whose cardiogenic shock necessitates mechanical support devices. First, the application of percutaneous peripheral arterial techniques to surgical procedures might expand the pool of patients eligible for such devices, as previously noted by operators who used peripheral angioplasty, stenting, or both to facilitate device placement in patients with lower-extremity vascular disease.[7,8] Second, using the body of a 20F sheath can overcome the femoral or subclavian tortuosity commonly encountered in patients with vascular disease—analogous to the insertion of a GuideLiner® catheter (Vascular Solutions, Inc.; Minneapolis, Minn) into a tortuous coronary artery to facilitate stent delivery.[9] Third, an upper-extremity approach for Impella placement might be preferable in patients with known severe stenoses of the lower-extremity arteries. Finally, and perhaps of most importance, the presence of a cardiac surgeon and an interventional cardiologist in the surgical operating room enabled us to combine their experience in advanced surgical and percutaneous techniques for the management of an individual patient's anatomic problem. Practice guidelines advocate a "heart-team approach" to early decision-making in advanced valvular or coronary disease management,[10] and we think that this approach can also be applied to the daily treatment of complex conditions, as in our patient.

In summary, the use of peripheral vascular techniques in the cardiac surgery operating room might help to increase the number of patients eligible for less invasive surgical approaches, such as the delivery of large mechanical support devices through small vascular anatomy. The combined expertise of surgeons and cardiologists—as recommended for clinical decision-making in patients with complex coronary or valvular conditions or cardiomyopathy—might also be extended to the intraprocedural care of patients with complex anatomy, to help navigate obstacles or complications within an individual procedure.

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