

Successful Implantation of a Left Ventricular Assist Device in a Patient with Heparin-Induced Thrombocytopenia and Thrombosis

Cassandra Garland, CCP, LP; David Somogyi, CCP

Perfusion Services, Department of Thoracic and Cardiovascular Surgery, The Cleveland Clinic, Cleveland, Ohio

Abstract: We report the case of a 27-year-old woman with signs of heparin-induced thrombocytopenia and thrombosis (HITT) and left heart failure presenting for urgent implantation of a left ventricular assist device (LVAD). HITT can occur in 4.2–6.1% of patients with LVADs. If the patient remains hemodynamically stable, implantation can be delayed for several months until the heparin/PF-4 antibodies decline allowing the use of heparin on cardiopulmonary bypass. However, in most cases related to car-

diogenic shock, surgery cannot be delayed. We present the case of a patient who underwent implantation of a HeartMate II LVAD and discuss management strategy using bivalirudin during cardiopulmonary bypass. **Keywords:** cardiopulmonary bypass (CPB), heart failure, left ventricular assist device, bivalirudin, Angiomax, heparin-induced thrombocytopenia and thrombosis, case report, heart failure operation, cardiogenic shock. *JECT. 2014;46:162–165*

In August 2012, a 27-year-old woman underwent an aortic valve replacement with a #19 On-X mechanical valve at an outside hospital. Her postoperative course was complicated by pulseless electrical activity arrest, an inferolateral myocardial infarction, low cardiac output syndrome, and hypotension, which resulted in the placement of a 40-cc intra-aortic balloon pump sheathless through the right femoral artery at the outside hospital.

She was subsequently transferred to our hospital in cardiogenic shock with a left ventricular ejection fraction of 10%. The patient was placed on venoarterial extracorporeal membrane oxygenation (ECMO) with heparin boluses administered as needed to maintain activated clotting times (ACTs) in the range of 180–200 seconds. On postoperative day 5, the intra-aortic balloon pump was removed and groin hemostasis was managed by applying handheld pressure, but efforts to wean the ECMO proved unsuccessful and the patient continued to require high-dose pressors. The patient was seen by the advanced heart failure team and the decision was made to insert a left ventricular assist device (LVAD). Preoperatively, how-

ever, the patient had a significant drop in her platelet count raising suspicion for heparin-induced thrombocytopenia and thrombosis (HITT), which was then confirmed with anti-PF4 antibodies and a positive serotonin release assay. Our institution has experience using bivalirudin for anticoagulation in multiple cases. A previously established protocol was reviewed and followed throughout the case without deviation.

On postoperative day 17, the patient entered the operating room for insertion of the Thoratec HeartMate II LVAD. A median sternotomy was recreated and bivalirudin was administered to achieve an ACT time two and a half times greater than the baseline (1), and the aorta was cannulated with a 21-French arterial cannula. Venous cannulation was then achieved through a dual-stage 28/36 venous cannula in the right atrium. A bivalirudin drip was started and 50 mg of bivalirudin was added to the circuit prime of the heart–lung machine.

Cardiopulmonary bypass was initiated and further dissection was done. The aorta was noted to be extremely friable. With a body surface area of 1.65 m², flows were calculated to be 3.3 L per minute at a 2.0 index and 3.9 L per minute at a 2.4 index. Patient was kept normothermic. Stagnation of blood in the pericardial well can lead to activation of the coagulation cascade that will lead to thrombosis in the pump reservoir. As a result, scavenged blood from the pericardium was collected in a cell saver (2) and transfused back to the patient after washing.

A circular ventriculotomy was performed on the apex of the heart while the patient was in Trendelenburg

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Address correspondence to: Cassandra Garland, CCP, LP, Care of David Somogyi, CCP, Department of Thoracic and Cardiovascular Surgery, The Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195. E-mail: cassiemgarland@gmail.com

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position. Next, a felt ring was sutured down around the ventriculotomy for reinforcement purposes, and the LVAD cuff was sewn in and tied down before being secured to the inflow cannula with sterile tie bands. A tunnel was then made through the abdomen to allow for placement of the drive line. The pump was placed into the pump pocket that had previously been formed.

The midascending aorta was partially clamped and the outflow cannula was sewn on. The clamp was removed, the ventricle was deaired, and the outflow graft was connected to the HeartMate II device. The HeartMate II was turned on and the RPMs were set at 8800. The patient was then weaned from cardiopulmonary bypass with low-dose epinephrine and milrinone after a 77-minute pump run. The heart–lung machine was reboled with 50 mg of bivalirudin and the circuit loop was reconnected at the field for recirculation purposes.

At this time, given that we had not used a cardiotomy sucker, a great deal of blood was lost from the patient to the cell saver and the patient became immensely hypovolemic, causing air to be pulled into the left ventricle. The patient then became hypotensive and the right ventricle began to fail. A vent was placed into the aorta, and the patient was initiated back on cardiopulmonary bypass. The patient was reboled with 60 mg of bivalirudin and the drip was restarted while patient was volume resuscitated through a Belmont rapid infusion machine.

During this period, the intra-aortic balloon pump was removed. The patient was then successfully weaned off of bypass, with the HeartMate II set at 8000 RPMs, after an additional 17 minutes. The patient's chest was kept open and a vacuum dressing was applied to the chest before transferring the patient to the intensive care unit.

Once the patient's coagulopathy resolved, she was brought back to the operating room the next day for chest washout and closure. Bivalirudin was initiated 24 hours post-LVAD insertion to maintain partial thromboplastin time values in the 45–65 range. Mean arterial pressures were kept above 70 mmHg.

On postoperative day 20, a tracheostomy was performed. An echo done on postoperative day 28 revealed an ejection fraction of 15%, severely decreased left ventricular systolic function, mildly decreased right ventricular systolic function, closure of the aortic valve during each cardiac cycle, and good placement of both cannulae. The patient was discharged on postoperative day 63. The patient continues to do well with plans to list her for heart transplant.

DISCUSSION

HITT, a complication in which the anticoagulant actually promotes the formation of blood clots, develops in

patients who have had prior exposure to heparin. Non-immune HIT occurs frequently without harm to the patient. Immune-mediated HIT occurs less frequently, yet poses greater danger to the patient as platelet counts drop by more than 50%, systemic reactions occur, and severe clotting (venous and/or arterial) is detected. Immune-mediated HIT should be considered if severe bruising is noted along the heparin injection site or on the extremities within 10 days after starting heparin therapy.

When HITT is confirmed through a positive PF4 antibody test, heparin is discontinued (3). Up to 70% of patients undergoing cardiac surgery develop these antibodies after exposure to heparin, whereas the prevalence of HITT in patients undergoing cardiac surgery post-surgery is only 2–3% (4). The antibodies have a half-life of 85 days. If surgery can be delayed until the antibody screen is negative, heparin may be used. If delaying the surgery is not feasible, a different anticoagulation method must be used.

Bivalirudin (Angiomax; The Medicines Company, Parsippany, NJ) is used for patients with heparin allergies who must be placed on cardiopulmonary bypass. It is a direct thrombin inhibitor with a rapid onset and half-life of 25 minutes in patients with normal renal function. Clearance of the drug correlates with the glomerular filtration rate of the patient (3). Patients with severe renal dysfunction may be prone to increased bleeding postoperatively.

Bivalirudin is a good alternative to heparin because it does not need a binding cofactor and does not activate platelets. Target ACT for cardiopulmonary bypass should be two and a half times the baseline ACT. There is no known reversal for the anticoagulant effects of bivalirudin, which makes excessive bleeding a major risk. Anticoagulation status can be monitored using ACT and/or thromboelastographic time perioperatively and activated partial thromboplastin time ratio and international normalized ratio levels postoperatively.

Following our institution's guidelines for bivalirudin use, a nonheparin-coated cardiopulmonary bypass circuit must be used. Bivalirudin is given as a bolus of 1 mg/kg before cannulation. An adequate ACT must be reached before cannulating. A 50-mg bolus is added to the pump prime once excess prime volume is removed. A direct infusion of 2.5 mg/kg/h of bivalirudin must be connected to the venous line on the pump (1). Bypass should be initiated as soon as possible. Anticoagulation for cell salvage suction is achieved by a drip of anticoagulant citrate dextrose (ACD) in addition to adding 15 mL of ACD per 100 mL of blood.

When using bivalirudin, it is essential to avoid stagnancy of blood. Intermittently circulate blood in purge lines and cardioplegia set. Maintaining a low reservoir level lessens the possibility of stagnation of the blood. If the patient has dilated heart chambers, inadequate drainage on bypass

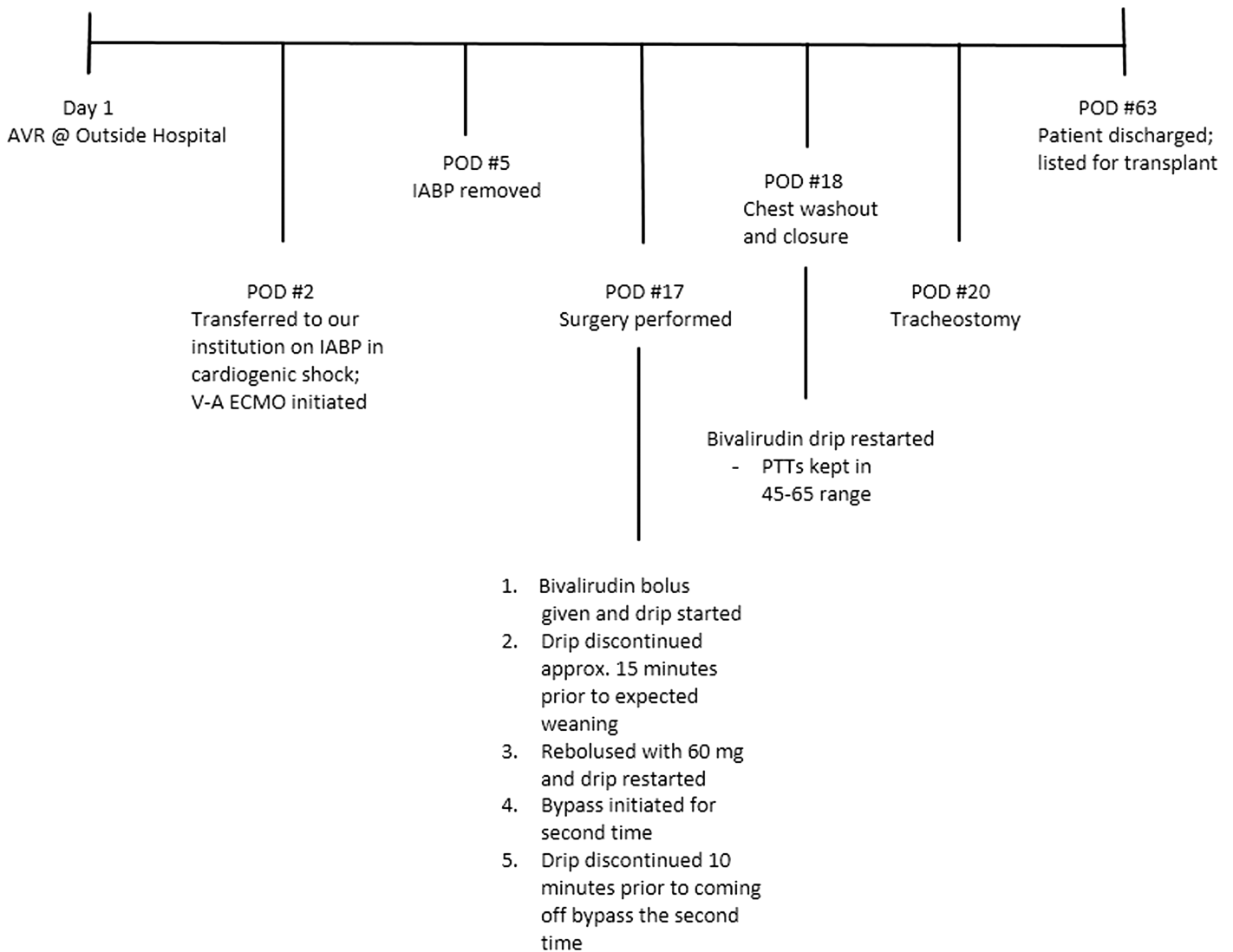


Figure 1. Timeline of patient's hospital stay, detailing bivalirudin and heparin specifics.

can lead to pooling of blood, which can lead to activation of the coagulation cascade that will lead to thrombosis in the pump reservoir (1). As a result, scavenged blood should be collected with cell saver suctioning and transfused back to the patient after washing (2).

Excessive volume should be pumped up into a citrated holding bag (1). Should this blood need to be used, calcium levels should be watched and adjusted accordingly. Hemoconcentration is not an option for excessive volume as a result of removal of bivalirudin (1).

Bivalirudin drips are discontinued 15 minutes before expected termination of bypass (1). Communication with the surgeon is extremely crucial throughout the entire procedure, but especially important for determining correct timing to terminate the drips. If the patient cannot be

weaned off bypass within 20 minutes, the drip should be started again and half the loading dose of bivalirudin should be given. On decannulation, if the patient is not hemodynamically stable, an arteriovenous loop may be made at the table by using a connector. Figure 1 is a timeline of the patient's stay at our institution, detailing bivalirudin and heparin specifics.

Studies such as the coronary artery bypass grafting (CABG) heparin-induced thrombocytopenia thrombosis syndrome (HITTS) on- and off-pump safety and efficacy (CHOOSE-ON) and EVOLUTION-ON trials have helped to establish protocols for the safe use of bivalirudin in patients with HITT. Although published literature on bivalirudin for LVAD implantations is limited, we report safe and successful use in patients with HITT.

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