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High-Risk Left Main Coronary Artery Bypass Surgery Supported by the Impella® Recover LP 2.5 Assist Device: An Alternative Insertion Technique

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ABSTRACT

Patients with high-risk coronary lesions such as left main stenosis and a severely depressed left ventricular ejection fraction are at risk of death and morbidity-related complications during coronary artery bypass surgery. Several alternative methods have been developed for managing this problem, but it is still challenging, even for highly experienced and well-equipped cardiac surgery centers. We report the case of a successful coronary artery bypass surgery supported by the Impella® Recover LP 2.5 assist device and using an alternative insertion technique for the ascending aorta in a patient with high-risk coronary lesions, such as left main disease.

INTRODUCTION

Patients with high-risk coronary lesions, such as left main stenosis and a severely depressed left ventricular ejection fraction, are at risk of death and morbidity-related complications during coronary artery bypass surgery. Several alternative methods have been developed for managing this problem, but it is still challenging, even for highly experienced and well-equipped cardiac surgery centers.

The availability of hemodynamic-support devices offers a promising option for reducing surgery-related complications in such high-risk procedures. No single approach has achieved wide acceptance, however, and device-related complications have discouraged wider use of these devices. The Impella® Recover LP 2.5 assist device (Abiomed, Aachen, Germany) may constitute a promising choice for circulatory support during high-risk coronary artery bypass surgery. The device, consisting of a catheter-mounted Archimedes screw driven by an internal electric motor, is inserted peripherally and positioned across the aortic valve in a retrograde fashion.

There is limited published information on the cardiac surgery experience with the Impella LP 2.5, and this report is the first description of its use in Turkey. We describe the case of a successful coronary artery bypass surgery supported with the Impella Recover LP 2.5 assist device and using an alternative insertion technique for the ascending aorta in a patient with high-risk coronary lesions, such as left main disease.

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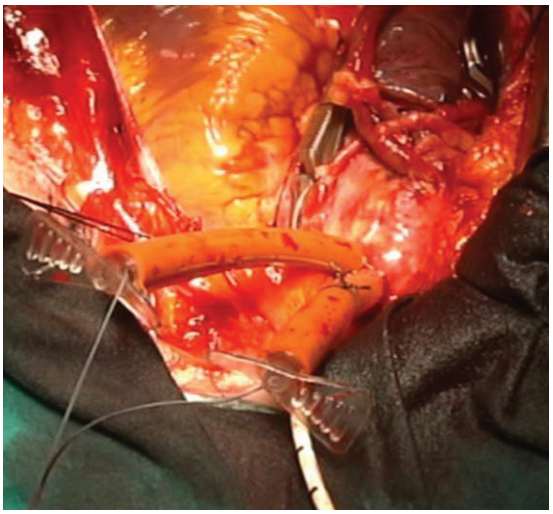
DEVICE DESCRIPTION

The Impella Recover LP 2.5 assist device is a microaxial rotary blood pump (4 mm in diameter, 12F) that is placed through the aortic valve to aspirate blood from the left ventricle and expel it into the ascending aorta. At its maximal rotation speed of 50,000 rpm, the pump can deliver an output of up to 2.5 L/min. The device can be inserted percutaneously via femoral arteries through a 13F femoral sheath and is mounted on a 9F pigtail catheter. The pigtail tip is inserted into the left ventricle to withdraw blood into the aorta. The Impella Recover LP 2.5 system is continuously purged with a solution of 10% dextrose and heparin (2500 IU). Purge flow rates typically range from 2 to 6 mL/h to continuously wash the pump and prevent thrombus formation in the pump. The distal part of the device is connected to a driving console that allows management of pump speed and displays the pressure difference between the inflow and outflow to ensure correct positioning of the device.

CASE REPORT

The patient, an 80-year-old man with critical left main disease, was admitted to the hospital for coronary artery bypass surgery. His medical history included a non–ST-elevated myocardial infarction, which was treated with percutaneous coronary angioplasty. The risk profile included hypertension, obesity, and severe chronic obstructive pulmonary disease (forced expiratory volume in 1 second [FEV1], 56%; FEV1/forced vital capacity, 60%). The patient, formerly a heavy smoker, had smoked one and a half packs of cigarettes a day for 50 years and had quit 15 years before. An echocardiography examination at admission revealed severe left ventricular dysfunction (ejection fraction, 34%) with hypokinesia in the apical, anteroseptal, and inferior walls. A coronary angiography evaluation documented left main disease with 80% stenosis. The left anterior descending artery showed diffuse



The Impella® Recover LP 2.5 system inserted into the ascending aorta and secured between 2 aortic cannulation snares.

calcification without critical stenosis. The circumflex coronary artery had 80% ostial stenosis, and the right coronary artery was subcritically stenotic. Duplex ultrasonography examinations of the bilateral carotid arteries revealed insignificant stenosis.

The preoperative logistic EuroSCORE predicted a 34.49% chance of mortality, and the standard EuroSCORE was 13% for this patient. The patient was considered a poor candidate for conventional on-pump coronary artery bypass surgery because of the critical chronic obstructive pulmonary disease. For this reason, after we obtained the patient's informed consent, we decided to perform coronary artery bypass surgery with assistance to the left ventricle provided by an intracardiac microaxial pump (Impella Recover LP 2.5).

The surgical procedure began with a median sternotomy, followed by preparation of the left internal mammary artery and saphenous vein conduits. After the first part of the surgery was performed, an incision was made in the right groin, and the right femoral artery and its branches were encircled with umbilical tape. A 0.035-in wire was inserted via needle insertion into the femoral artery. The wire did not advance, however, and it stopped at the level of the right common iliac artery. Therefore, a decision was made to abandon the use of the right side for vascular access. We shifted our attention to the left side and used the Seldinger technique for this purpose because of possible stenosis due to atherosclerosis. After percutaneous cannulation of the left side, the same problem occurred: The 0.035-in wire did not advance forward and stopped at the level of left common iliac artery. Once again, we felt that the procedure was unsafe and decided to use an alternative access for the Impella Recover LP 2.5. After administration of 5000 IU of heparin, we put an aortic purse suture in the ascending aorta with 2/0 Ti-Cron multifilament polyester suture (Covidien/Syneture, Dublin, Ireland). After insertion of the purse suture as in aortic cannulation, the 0.035-in wire was introduced through the needle, and the Impella Recover LP 2.5 system was advanced over the wire across the aortic valve under the guidance of transesophageal echocardiography and a C-arm radiologic device. The output of the Impella Recover LP 2.5 system was 2.9 L/min at maximal speed, and a stable blood pressure of 130/65 mm Hg was reached (Figure). The intervention was uneventful, and the hemodynamic status of the patient remained stable during the procedure. The Impella Recover LP 2.5 system was removed immediately after the bypass grafts were completed. The patient was transferred to the intensive care unit in stable condition, and the follow-up remained uneventful thereafter. He was discharged from the hospital on postoperative day 7.

DISCUSSION

Considerable stenosis of the left main coronary artery typically identifies an anatomic subset requiring coronary artery bypass grafting for revascularization. Patients with left main coronary artery disease, severe left ventricular dysfunction, and chronic obstructive pulmonary disease are often unsuitable surgical candidates, especially those with severe comorbidities. Beating-heart surgery is considered less invasive to the patient than conventional coronary artery bypass surgery. The most important advantage is the avoidance of the cardiopulmonary bypass system. There is still some debate on this issue, however, and many surgeons fear that beating-heart surgery may actually be more invasive to the heart. The most disturbing changes occur once the vessel is occluded. One possible approach to overcome some of these problems is to use mechanical support systems during beating-heart surgery.

The mechanical support system should be less invasive than cardiopulmonary bypass. Most mechanical support systems require inflow cannulation and outflow cannulation for grafting, and the surgical insertion of these cannulae can be as traumatic as the installation of the cardiopulmonary bypass system.

The Impella Recover LP 2.5 device is the most effective system for supporting the heart. Its use is minimally invasive, and the miniaturized rotary blood pump has sufficient power to take over the function of the left ventricle [Mueller 2002]. The inflow cannula is positioned across the aortic valve, and the pump sucks the blood out of the left ventricular cavity and expels it into the ascending aorta. Typically, the cannula is placed through a graft (6-8 mm) sutured onto the ascending aorta when a central approach is preferred.

The Impella Recover LP 2.5 system has some advantages. It can be easily and rapidly inserted percutaneously via a retrograde approach, it provides hemodynamic stability, and unloading of the left ventricle provides myocardial protection against ischemia. The Impella Recover LP 2.5 system provides a cardiac output that is superior to that of an intra-aortic balloon pump. In addition, there may be increased stability of the anastomotic site, allowing a more precise suturing technique. Finally, it may become possible to manipulate the heart in order to reach an area difficult to access.

Hemolysis and thromboembolism are very rare with the device. Iliofemoral duplex ultrasonography is strongly

recommended before implantation. In our case, postoperative duplex ultrasonography revealed bilateral iliofemoral angulations and multiple atherosclerotic lesions.

The only obstacle to use of the Impella Recover LP 2.5 system is the total cost of the system; however, the myocardial protective effect can be the most important factor, especially with high-risk patients with the complication of a limited left ventricular function.

The Impella Recover LP 2.5 has been designed for use with the Seldinger technique, with a pigtail at the tip of the inflow cannula through the femoral artery. Insertion is simple and does not require systemic heparinization. Recently, an alternative insertion technique via the right axillary artery has been described [Sassard 2008]. Implantation through a graft interposition has previously been described and used as an alternative to an intra-aortic balloon pump [Cochran 2002]. There are probably several issues with this approach, however. First, it is risky to put a side clamp on an atherosclerotic aorta; on the other hand, most surgeons prefer to avoid the possibility of crush embolization with a single-clamp technique. Second, as we all know, the ascending aorta is sometimes short with no space for the proximal anastomosis if multiple bypasses are planned. In such cases, sewing a 6- or 8-mm graft to the ascending aorta would make the procedure more difficult. Third, at the end of procedure there will be some remnant of the interposed graft in the aorta, which can be the cause of subsequent thrombus formation. Fourth, using an interposition graft adds an additional cost to the procedure.

Experience with percutaneous systems of circulatory support has rarely been reported in the literature. The Impella microaxial pump is an effective tool for unloading the left ventricle, and different access sites can be used for this purpose. Given the ease of insertion, flexibility, and low rate of complications associated with high-output left ventricular support, we believe that our insertion technique with a purse suture may contribute to the evaluation of the Impella Recover LP 2.5 system and the design of suitable accessories for this purpose.

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