Supported High-Risk Cardiac Surgery using an Intra-Aortic Balloon Pump Catheter via the Left Brachial Artery in a Patient Displaying Total Occlusion of the External Iliac Arteries

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Abstract

The intra-aortic balloon pump (IABP) was first successfully used by Kantrowitz and colleagues in 1968 . Traditionally, IABPs are inserted via the femoral artery. However, this approach is usually contraindicated in patients with severe peripheral vascular disease (PVD). Noël and colleagues were the first to report transbrachial insertion of an 8 Fr IABP catheter for ventricular assistance during percutaneous coronary intervention. However, in almost all the reported cases in which transbrachial insertion of an IABP was performed, it was done for hemodynamic support during percutaneous coronary intervention or coronary artery bypass grafting. We present a case involving a patient with endocarditis-associated structural aortic valve deterioration and severe left ventricular dysfunction, as well as total occlusion of both external iliac arteries. The patient was successfully treated using a 7 Fr transbrachial IABP. A left transbrachial percutaneous approach may thus be a safe and effective alternative if femoral artery access cannot be achieved.

Introduction

The intra-aortic balloon pump (IABP) was first used successfully by Kantrowitz and colleagues (1) in 1968 for patients with cardiogenic shock. Intra-aortic balloon counterpulsation is commonly used to help stabilize hemodynamic parameters and improve end-organ function. Traditionally, IABPs are inserted via the femoral artery; however, this approach is usually contraindicated in patients with severe peripheral vascular disease (PVD). The axillary and transaortic routes have been cited in case reports as alternative routes; however, these frequently require surgical intervention.(2, 3) We describe a case involving a percutaneously-placed IABP via a brachial approach for a high-risk cardiac surgery patient. The patient exhibited severely impaired left ventricular systolic function, as well as aortic valve infective endocarditis, resulting in symptomatic heart failure. Repeat surgery was required for this patient, following severe deterioration of a previously-implanted Freestyle bioprosthesis as a result of bacterial infection . We expected that counterpulsation therapy delivered via an IABP would help to wean the patient off the cardiopulmonary bypass and maintain hemodynamic stability during the postoperative course. However, both external iliac arteries were totally occluded, so we decided to insert the IABP via the brachial artery. Although transbrachial insertion of an IABP has previously been reported , almost all of the reported cases were for hemodynamic support during a percutaneous coronary intervention or coronary artery bypass grafting. In our case, due to the high risk of the repeated surgery, as well as the absence of external iliac arteries, transbrachial IABP was effective and useful for perioperative course.

Case Report

A 63-year-old male with endocarditis-associated structural aortic valve deterioration and severe left ventricular dysfunction (approximately 20% ejection fraction) was referred to our department for surgical treatment.

The patient had undergone a Bentall operation using a Medtronic Freestyle stentless aortic bioprosthesis 10 years earlier, and had also been diagnosed with rectal carcinoma at another hospital. He was unable to undergo surgery for the carcinoma, due to left ventricular dysfunction and heart failure. We suspected that the left ventricular dysfunction was caused by aortic regurgitation, so we decided to treat the aortic valve first. The aortic valve re-replacement via resternotomy was a high-risk operation because of the left ventricular dysfunction, so we decided that an assisting device would be necessary to wean the patient off the cardiopulmonary bypass and maintain hemodynamic stability during the postoperative course. We elected to use an intra-aortic balloon pump due to its ease of use and its access through the femoral artery. However, both of the patient's external iliac arteries were occluded or displayed aplasia. Thus, we decided to insert the IABP via the brachial artery instead.

In the operating theatre, the left brachial artery was used for access and was cannulated using a 7 Fr Super Arrow-Flex Sheath Introducer (Teleflex Medical, PA, US). A 0.025"Radifocus Guidewire (Terumo, Tokyo, Japan) was introduced into the left brachial artery and advanced up to the subclavian artery under fluoroscopic guidance. The acute bend between the descending thoracic aorta and the left subclavian artery made guiding the wire down to the descending aorta difficult. To facilitate the advancement of the guidewire selectively down to the descending aorta , a 6 Fr Judkins R diagnostic catheter was advanced over the guidewire and positioned at the ostium of the left subclavian artery with its tip pointing downward to the descending aorta, as confirmed on fluoroscopy. The guidewire was then advanced selectively down the descending aorta. The 7 Fr IABP (Tokai Medical Products, Aichi, Japan) was advanced over the guidewire and positioned in the descending aorta. The IABP was not activated before the surgery, due to the patient's aortic value regurgitation pathology.

The cardiac surgery was started only once the safe placement of the IABP had been ensured. The aortic valve was re-replaced with a new aortic valve bioprosthesis via resternotomy. The Freestyle bioprosthesis was visibly infected, so the leaflets were perforated and dissected to remove the vegetation . While the patient was weaned off the cardiopulmonary bypass, the transbrachial IABP was activated to maintain hemodynamic stability. We were able to safely wean the patient off the cardiopulmonary bypass using the IABP support. The postoperative course was satisfactory. On postoperative day one, the hemodynamic condition of the patient was sufficiently stable to safely withdraw the IABP assistance. We therefore removed the IABP and applied manual compression to the inserted left brachial artery while ensuring patent hemostasis.

Transthoracic echocardiography, which occurred three months after the cardiac operation, revealed improvement of left ventricular function, with a recovery in ejection fraction to 40%. The rectal carcinoma surgery was performed six months after the cardiac surgery. Over five years later, the patient is still alive and attends our outpatient clinic.

Comments

The intra-aortic balloon pump offers only limited circulatory support, and has not shown prognostic benefits in recent clinical trials. For this reason, and according to the latest guidelines, its use is not routinely recommended in patients with cardiogenic shock. Nevertheless, it is still widely available in most centers, and facilitates an increase in diastolic coronary flow during the perioperative course that might be beneficial in patients with high-risk coronary anatomy and impaired left ventricular systolic function. Noël and colleagues first reported the transbrachial insertion of an 8 Fr IABP catheter for ventricular assistance during percutaneous coronary intervention.(4) Bundhoo and colleagues recently suggested that a left transbrachial approach for IABP insertion might reduce the risk of neurological complications relative to the standard transfemoral approach.(5)

Transaortic and axillary placement of IABPs have also been described.(2, 3) However, these techniques are costly and risky, require major vascular intervention, and necessitate the use of general anesthesia. The brachial artery is superficial, easily accessible, and amenable to manual compression to achieve adequate hemostasis. Although transbrachial insertion of IABPs has been reported, in almost all cases it was for hemodynamic support during a percutaneous coronary intervention or a coronary artery bypass grafting.

We used the transbrachial IABP in a high-risk repeat cardiac surgery, as well as to wean the patient off the cardiopulmonary bypass and maintain hemodynamic stability during the postoperative course.

However, this technique has several potential disadvantages . First, the use of a catheter via the brachial approach seems to be riskier than via the femoral approach in terms of access site complication, such as limb ischemia, or vascular laceration necessitating surgical repair. Second, the catheter shaft may kink during insertion, which could cause narrowing or closure of the inner lumen of the catheter and eventually lead to insufficient balloon dilatation. Third, the risk of cerebrovascular events increases, because the catheter crosses over the ostium of the vertebral and internal cerebral arteries.

In our case, we used the left brachial route as opposed to the right. Despite being technically more challenging, we chose the left side because it avoided all the cerebral vessels (apart from the left vertebral artery) and reduced the risk of cerebral embolization. Furthermore, it allowed the surgeon to operate from the right side of the patient.

To prevent the catheter from developing a kink, we used the Super Arrow-Flex Sheath Introducer (Teleflex Medical, PA, US), which has a coil-wire design that allows the sheath to flex at any point and in any direction without kinking or losing support. It also exhibits good steerability for negotiating tortuous anatomies. After IABP placement, we monitored for limb ischemia using digital pulse oximetry, radial pulse palpation, hand temperature monitoring, and the application of systemic heparinization. The ECG was used as the trigger signal, since we were unsure whether the 'upside down' IABP would sense the central aortic pressure sufficiently for the arterial pressure wave form to be effective as the triggering mechanism.

In conclusion, adequate and sustained hemodynamic support using a transbrachial IABP was achieved in our high-risk patient without significant complications, thus reducing perioperative risk. A left transbrachial percutaneous approach may thus be a safe and effective alternative if femoral artery access cannot be achieved.

References

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Figure Legends

Fig. 1: Three-dimensional computed tomography of the aorta. This reveals the total occlusion of the bilateral external iliac arteries.

Fig. 2: (Left) A 0.025" Radifocus Guidewire (Terumo, Tokyo, Japan) was introduced into the left brachial artery and advanced downward to the descending aorta. A 7 Fr Super Arrow-Flex Sheath Introducer (Teleflex Medical, PA, US) was advanced over the guidewire and positioned at the ostium of the left subclavian artery (red arrow) with its tip pointing downward to the descending aorta. The 7 Fr intra-aortic balloon pump (Tokai Medical Products, Aichi, Japan) was advanced over the guidewire and positioned in the descending aorta. (Right) Transbrachial access for intra-aortic balloon pump support.