Intra-aortic Balloon Counterpulsation: Indications and pitfalls

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Objectives:

At the conclusion of this lecture, participants should be able to:
1. Understand the indications for placement of an intra-aortic balloon pump (IABP).
2. Understand the relevant hemodynamic changes induced by use of an IABP.
3. Understand the appropriate placement of an IABP and how to assess the balloon’s position.
4. Be able to troubleshoot suboptimal IABP settings, particularly those related to timing, filling, and triggering.

Description:

The Intra-aortic Balloon Pump (IABP) is a temporary mechanical device used to stabilize and improve native cardiac function. Since its introduction into clinical practice in 1968, the IABP is utilized to restore cardiac function through a variety of mechanisms, including; decreasing left ventricular end-diastolic volume, increasing blood flow to the coronary arteries, decreasing myocardial oxygen demand by decreasing left ventricular wall tension, and decreasing left ventricular afterload, (Kantrowitz et al, 1968). In addition to improving cardiac function, there are also several observed secondary effects to heart rate, pulmonary artery pressures, and perfusion to other vital organs. Today, it is estimated that there are over 100,000 IABP catheters inserted worldwide annually (Babaev et al, 2005).

Indications:

IABP therapy is considered to be a class I indication (ACC/AHA) for the management of cardiogenic shock that does not respond to pharmacologic support (Sjauw et al, 2009). IABPs are also commonly indicated in patients with unstable angina, serving as a bridge to further percutaneous interventions or cardiac surgery. In the operating theater, an IABP is frequently employed to stabilize patients with acute myocardial infarction during emergent cardiac surgery. Patient risk factors that warrant placement of an IABP include; LV dysfunction, severe left main disease, low ejection fraction (< 30%), and cardiomyopathy. Weaning from Cardio-Pulmonary Bypass (CPB) may be facilitated with an IABP in conjunction with inotropic support to increase both coronary and systemic perfusion.

Contraindications:

The use of an IABP is contraindicated in patients with known aortic dissections and aneurysms, as the placement of the balloon may induce vessel rupture. This would also include patients with aortic stents for fear of migration or vessel rupture. Additionally, aortic regurgitation is an absolute contraindication, since the
counterpulsation would exacerbate valvular insufficiency. Generally speaking, an IABP is not indicated in any clinical condition that does not anticipate functional recovery, or bridging to a long-term technology. IABP insertion may also serve problematic in patients presenting with peripheral vascular or occlusive aortoiliac disease.

Despite strong recommendations from the American College of Cardiology / American Heart Association as well as the European Society of Cardiology for IABP utilization in STEMI (ST-Segment Elevation Myocardial Infarction), there is a growing body of literature that shows no efficacy benefit. The lack of active cardiac support, and the need to have some level of residual native left ventricular function may not be enough to reverse acute cardiogenic shock. In these cases, the use of a short-term ventricular assist device would significantly reduce the workload of the heart and facilitate functional recovery. However, the invasive nature of these devices carries with it additional risks and morbidities (Thiele, 2005). Clinical trials are ongoing to measure whether the incorporation of these active circulatory assist devices in this patient population has a positive effect on survival.

**Insertion**

IABP balloon catheter sizes vary according to the patient’s height, ranging from 25 cc to 50 cc balloon volume offerings. A fully expanded IABP balloon should not exceed 80-90% of the diameter of the patient’s descending aorta (Borghardt, 2010). The most common site of catheter insertion is the femoral artery. A modified Seldinger technique is employed to insert the sheath and catheter percutaneously into the femoral artery. When femoral access is not an option, other peripheral arteries such as the subclavian and axillary arteries have previously reported. Proper placement is confirmed to ensure that the catheter tip is positioned just distal to the left subclavian artery.

**Timing**

The most common triggers used for balloon inflation and deflations are the EKG waveform and systemic arterial pressure. When properly timed, the IABP balloon should inflate at the onset of diastole, and deflate at the beginning of LV systole. This timing also corresponds to the opening and closing of the native aortic valve. Improper timing of the IABP during either inflation or deflation can lead to hemodynamic instability. Special care should be taken to ensure that cardiac cycles and waveforms are evaluated for proper balloon timing. The 4 associated complications with balloon timing include:

1. Early inflation
2. Early deflation
3. Late inflation
4. Late deflation
Complications
Placement of the device through the femoral artery may induce vascular complications such as vessel dissection, thrombosis, and distal limb ischemia. Mechanical complications from the IABP device may include balloon rupture, gas emboli release, and console malfunction/timing. Although patients are systemically anticoagulated during IABP support, hemorrhage and thrombosis are still remaining significant complications.


