Intra Aortic Ballon Therapy

C.Uma[1], A.Padmavathy[2]
[1, 2]VIGNESH NURSING COLLEGE

I. INTRODUCTION

Intra-aortic balloon pump (IABP) remains the most widely used circulatory assist device in critically ill patients with cardiac disease. The National Centre of Health Statistics estimated that IABP was used in 42 000 patients in the USA in 2002. Advances in technology, including percutaneous insertion, smaller diameter catheters, sheath less insertion techniques, and enhanced automation, have permitted the use of counter pulsation in a variety of settings, with greater efficacy and safety.

HISTORY OF INTRA AORTIC BOLLON THERAPY

Adrian kantrowitz (october4,1918-november 14,2018) was an American cardiac surgeon was the father of intra aortic balloon therapy. In 1958, Harken suggested the removal of some of the blood volume via the femoral artery during systole and replacing it rapidly in diastole as a treatment for left ventricular (LV) failure, so called diastolic augmentation. Four years later, Moulopoulos and colleagues[3] developed an experimental prototype of an IABP whose inflation and deflation were timed to the cardiac cycle. The first clinical application of a successful treatment with IABP was reported in 1967.Intr aortic balloon pumping was advocated successfully in a 45 year old female who had sustained a myocardial infarction and was hypotensive, comatose and anuric in severe carcinogenic shock. In 1968, Kantrowitz[1] reported improved systemic arterial pressure and urine output with the use of an IABP in two subjects with carcinogenic shock, one of who survived to hospital discharge. Percutaneous IABs in sizes 8.5 – 9.5 French (rather than 15 French used earlier) were introduced in 1979, and shortly after this, Bergman and colleagues[4] described the first per-cutaneous insertion of IABP. The first pre folded IAB was developed in 1986

Basic principles of counter pulsation

Counter pulsation is a term that describes balloon inflation in diastole and deflation in early systole. Balloon inflation causes 'volume displacement' of blood within the aorta, both proximally and distally. This leads to a poten- tial increase in coronary blood flow and potential improvements in systemic perfusion by augmentation of the intrinsic 'Windkessel effect', whereby potential energy stored in the aortic root during systole is converted to kinetic energy with the elastic recoil of the aortic root.

Definition:

The Intra-aortic balloon pump (IABP) is a mechanical device that increases the myocardial oxygen perfusion while at the same time it increases the cardiac output. Increasing cardiac output increases coronary blood flow and therefore myocardial oxygen delivery.

Mechanism

IABP consists of a cylindrical polyethylene balloon that sits in the aorta, approximately 2 centimetres (0.79 in) from the left subclavian artery and counter pulsates. That is, it actively deflates in systole, increasing forward blood flow by reducing afterload through a vacuum effect. It actively inflates in diastole, increasing blood flow to the coronary arteries via retrograde flow. These actions combine to decrease myocardial oxygen demand and increase myocardial oxygen supply.[2] [3] [4]

A computer-controlled mechanism inflates the balloon with helium from a cylinder during diastole, usually linked to either an electrocardiogram (ECG) or a pressure transducer at the distal tip of the catheter; some IABPs, such as the Data scope System 98XT, allow asynchronous counter pulsation at a set rate, though this setting is rarely used. Helium is used because its low viscosity allows it to travel quickly through the long connecting tubes, and has a lower risk than air of causing an embolism should the balloon rupture.

Physiological effects of IABP therapy

The primary goal of IABP treatment is to improve the ventricular performance of the failing heart by facilitating an increase in myocardial oxygen supply and a decrease in myocardial oxygen demand. Although these effects are predominately associated with enhancement of LV performance, IABP may also have favorable effects on right ventricular (RV) function by complex mechanisms including accentuation of RV myocardial blood flow, unloading the left ventricle causing reduction in left atrial and pulmonary

vascular pressures and RV afterload.[5] IABP inflates at the onset of diastole, thereby increasing diastolic pressure and deflates just before systole, thus reducing LV afterload. The magnitude of these effects depends upon:

(i) *Balloon volume*: the amount of blood dis- placed is proportional to the volume of the balloon.
(ii) *Heart rate*: LV and aortic diastolic filling times are inversely proportional to heart rate; shorter diastolic time produces lesser balloon augmentation per unit time.
(iii) *Aortic compliance*: as aortic compliance increases (or SVR decreases), the magnitude of diastolic augmentation decreases.

Indications

- Acute myocardial infarction
- Acute congestive heart failure exacerbation with hypotension
- As prophylaxis or adjunct treatment in high risk percutaneous coronary intervention
- Refractory LV failure
- Acute mitral regurgitation due to papillary muscle rupture or ventricular septal rupture
- Low cardiac output state after coronary artery bypass graftig surgery
- Cardiogenic shock
- Refractory ventricular arrhythmias
- Acute MR and VSD
- Cardiomyopathies
- Catheterization and angioplasty
- Sepsis
- Refractory unstable angina
- Infants and children with complex cardiac anomalies[10]
- Cardiac surgery
- Weaning from cardiopulmonary bypass

Contraindications

- Absolute
- Aortic regurgitation
- Aortic dissection
- Chronic end-stage heart disease with no anticipation of recovery
- Tachyarrhythmias
- Aortic stents
- Severe peripheral vascular disease
- Major arterial reconstruction surgery
- Uncontrolled sepsis
- Abdominal aortic aneurysm

Equipments

Intra aortic balloon pump kit: that includes intra aortic balloon pump system with IABP catheter, arterial dilator, a guide wire, angiographic needle

- Surgical mask, sterile gloves and gowns, sterile drapes
- 1%lidocaine solution
- ECG/pressure cable from external source into the IABP console
- Pressure monitoring set-up (transducer, pressure cable, saline, pressure bag)
- Sterile prep solution that includes povidone iodine solution with alcohol
- 5 cc syringe,25 guage needle
- Scalpel handle with a blade
- Sterile saline and lubricant
- Sterile transparent tape and dressing
- Tissue clamp
- 2-0 silk suture
- Safety razor
- 0.035j guide wire
- Fluroscopy device

Prior to inversion of IABP, informed consent is necessary with a clear explanation of risks and benefits of IABP insertion.

Personnel

The provision of care of patients who require an intra aortic balloon pump is in the ICU setting under continuous cardiac monitoring and arterial line care and management. It is imperative that health care providers must be accredited in IABP insertion and management and can identify the earlier signs of malfunctioning or the complications related to the device and manage them as per recommended protocols, an inter professional team is required to provide best integrated care, and the team may include an interventional cardiologist, intense visit, accredited intensive care or coronary care unit nurse, and or cardiothoracic surgery team, depending on whether the patient has a primary cardiac surgical illness.

Preparation

Before insertion of IABP, informed consent is necessary, with a clear explanation of risks and benefits of IABP device insertion, with concise instructions should about

the post procedure care. These instructions include not to flex the leg if femoral artery access of that leg was the entry point for IABP insertion, and inability to walk till the device is in place in case of femoral artery access used for device insertion.

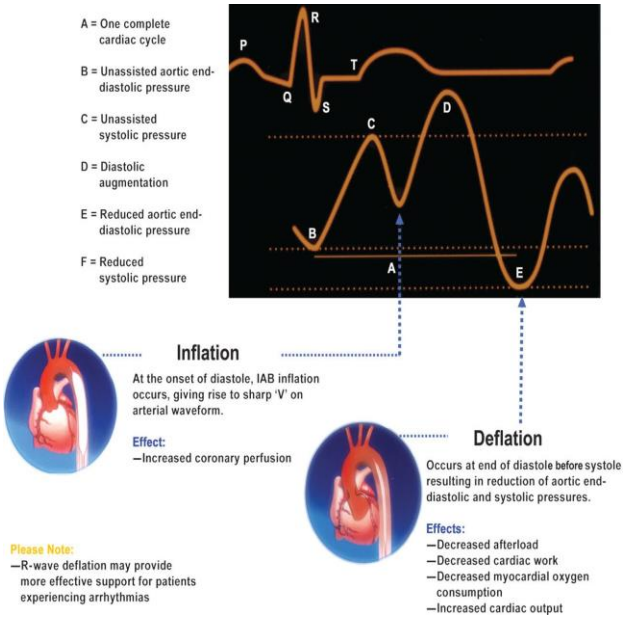
Before the procedure, the patient requires a thorough evaluation of any bleeding diathesis, infection, and presence of severe peripheral arterial disease.

The patient is positioned supine, and adherence to the sterile technique should be practiced to insert the device.

Procedure of IABP

After the implementation of sterile techniques to prepare the femoral catheterization site and application of local anesthesia, the angiographic needle is inserted into the common femoral artery below the inguinal ligament at an angle of 45 degree or less.

- The fluroscopic device can be used to ensure the location of angiographic needles into the common femoral artery as the arterial puncture above the inguinal ligament is strongly associated with retro peritoneal hemorrhage and arterial puncture at or below the femoral artery bifurcation is associated with acute limb ischemia.
- After ensuring adequate placement of the radiographic needle, the J-tip pf 0.035" guide wire gets inserted and advanced through the angiographic needle into the femoral artery.
- The angiographic needle is removed over the guide wire while keeping the guide wire in place.
- A small incision with the help of the blade is made in the skin at the site of insertion of the guide wire to facilitate insertion of sheath introducer.
- With the help of introducer, dilator to be introduced over the guide wire and advanced it in a rotatory fashion into the femoral artery, the sheath tract can further prepared to facilitate the insertion of the introducer sheath into the artery.
- The introducer sheath gets placed over the guide wire, and then 0.035 guide wire is removed while leaving the introducer sheath in the arterial lumen. It is followed by insertion of J- tube of the 0.018" guide wire (IABP guide wire) through the introducer sheath and advanced into the thoracic aorta.
- IABP catheter is prepared for insertion. Balloon preparation is by establishing a vacuum with the help of a syringe by applying aspiration, and the central catheter lumen is flushed with sterile saline to ensure patency.
- The IABP catheter is inserted and advanced over the 0.018"guide wire to the proper positioning of the balloon in the aorta. The location of the intra aortic balloon with its tip lying distal to the left subclavian artery and the proximal portion ending above the origin of renal arteries is considered as "safe zone" and the confirmation of position can be chest x-ray or fluoroscopy.
- Following guide wire removal .and the central lumen of the catheter is flushed and connected to the transducer to measure intra-aortic pressure. The IABP catheter gets connected to the extender catheter, which then connects to the IABP console.



Weaning:

- Counter pulsation may be reduced from 1:1 to 1:2 and finally 1:3 depending on the patient's haemo dynamics
- Do not set the pump at 1:3 unless for weaning and prior to removal. There is an increased risk of thrombus formation at counter pulsation of 1:3
- Weaning from IABP should be considered when the inotropic requirements are minimal, thus allowing increased inotropic support if needed. Weaning is achieved gradually (over 6 – 12 h) reducing the ratio of augmented to non-augmented beats from 1:1 to 1:2 or less and/or decreasing the balloon volume. The balloon should never be turned off *in situ* except when the patient is anti coagulated because of the risk of thrombus formation on the balloon.

Patient care should be carried out with three primary goals in mind:

(i) evaluation in terms of hemodynamic status, systemic per- fusion, and relief of cardiac symptoms;
(ii) observation for early signs of complications including limb is chaemia, balloon mal positioning, thrombus formation, bleeding, and infection; ensuring proper functioning of IABP, including correct timing, consistent triggering, and troubleshooting of alarms.

Nursing Care:

- Transduce the aortic arterial line (balloon lumen) to the Datascope pump and level with the patient's mid-axillary line.
- For arterial flush bag use normal saline 500mls with heparin 1,000 u/s.
- Hourly monitoring of:
  - heart rate and rhythm
  - record systolic/diastolic/mean arterial pressures and diastolic augmentation (Use the BP obtained from the Data scope pump when titrating drugs)
  - pedal pulses distal to the catheter site (Doppler may be necessary to assess pulse)
  - Radial pulse (If the catheter migrates forward it could compromise blood flow to the L) subclavian artery).
  - Colour, temperature and capillary refill
  - Sensation and movement of both lower extremities.
- Patient to be log rolled or Jordan lifted and the end of the bed elevated no more than 30^0 to prevent catheter migration and arterial puncture.
- Careful monitoring of renal function (The catheter sits above the bifurcation of the renal arteries - backward migration may compromise blood flow to the kidneys).
- The balloon should not remain immobile for >20 minutes while insitu due to risk of thrombus formation.
- Assess insertion site each shift for redness, ooze
- Change dressing porn
- Carefully monitor the insertion site for signs of bleeding, infection, haematoma, or compartment syndrome of the affected limb.
- Heparin insertion according to protocol may be initiated at 24 hours.

REFERENCES

[1] Kantrowitz A. Experimental augmentation of coronary flow by retardation of the arterial pressure pulse. Surgery 1953; 34: 678–87.
[2] Bergman HE, Casarella WJ. Percutaneous intra-aortic balloon pumping:initial clinical experience. Ann Thorac Surg 1980; 29:153–5.
[3] Mercer D, Doris P, Salerno TA. Intra-aortic balloon counter pulsation in septic shock. *Can J Surg* 1981; 24: 643 – 5.
[4] Pinkney KA, Minich LL, Tani LY et al. Current results with intra aortic balloon pumping in infants and children. *Ann Thorac Surg* 2002; 73: 887– 91.
[5] Tahir M.Khan;Abdul H. Siddiqui. Intra–Aortic balloon pump. Statepearls publishing. May 5, 2020.
[6] Elias V Haddad, MD. Inra-aortic Balloon Counter pulsation, Medscape. Dec 04, 2015.
[7] Mary Elizabeth king BS, R.N. Basic care of patients during intra aortic balloon pumping. Cardio vascular disease, bulletin of the texas heart institution, vol 4, nov-4.
[8] https://www.ncbi.nlm.nih.gov/books/NBK542233.