

# IABP

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# IABP

- Intra aortic balloon pump is a device that **increase myocardial oxygen delivery** by diversion of cardiac blood flow to the vital organs.
- **Decrease in myocardial oxygen demand** by decreasing the work load on the left ventricle by decreasing the aortic end diastolic pressure(**Afterload**).
- At present it is the simplest and most frequently used circulatory assist device

# Major parts of IABP

- Intra-aortic balloon catheter
- Machine



# History

- **KANTROWITZ** described augmentation of coronary blood flow by retardation of the arterial pressure pulse in animal model in 1952
- 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 the treatment for left ventricular failure.

# History

- Four years later **MOULOPOULOS** and colleges developed an experimental prototype of an IABP whose inflation and deflation were timed to the cardiac cycle
- In 1958 **KANTROWITZ** imported improved systemic arterial pressure and urine output with use of IABP in 2 subjects with cardiogenic shock, one of who survived

# History

- Percutaneous IAB's in sizes 8.5 to 9.5 French were introduced in 1979 and shortly after this **BERGMAN** described the first percutaneous insertion of IABP
- The first pre-folded IAB was developed

# Indications

- Unstable angina
- Acute MI
- Mechanical complication following MI
- Cardiogenic shock
- Adjacent to PTCA
- Adjacent to cardiac catheterization
- Operative(pre post intra)
- Angioplasty
- Acute MR and VSD
- Weaning from CPB
- Refractory LV failure
- Ventricular arrhythmias
- Sepsis

# Contraindications

## **ABSOLUTE**

- Thoracic or abdomen arch aneurysm
- Occluded aorta
- Aortic regurgitation
- Aortic dissection
- Aortic stents



# Contraindications

## **RELATIVE**

- Aortic insufficiency
- Severe peripheral valvular disease
- Uncontrolled sepsis
- Tachyarrhythmias
- Major arterial reconstruction surgery

# Complications

- Limb ischemia
- Thromboembolism
- Vascular injury
- Infection
- Aortic dissection
- Balloon rupture
- Transient loss of peripheral pulse
- Aortic dissection
- Hematological changes (hemolysis, thrombocytopenia)
- Cardiac tamponade

# How does it works???

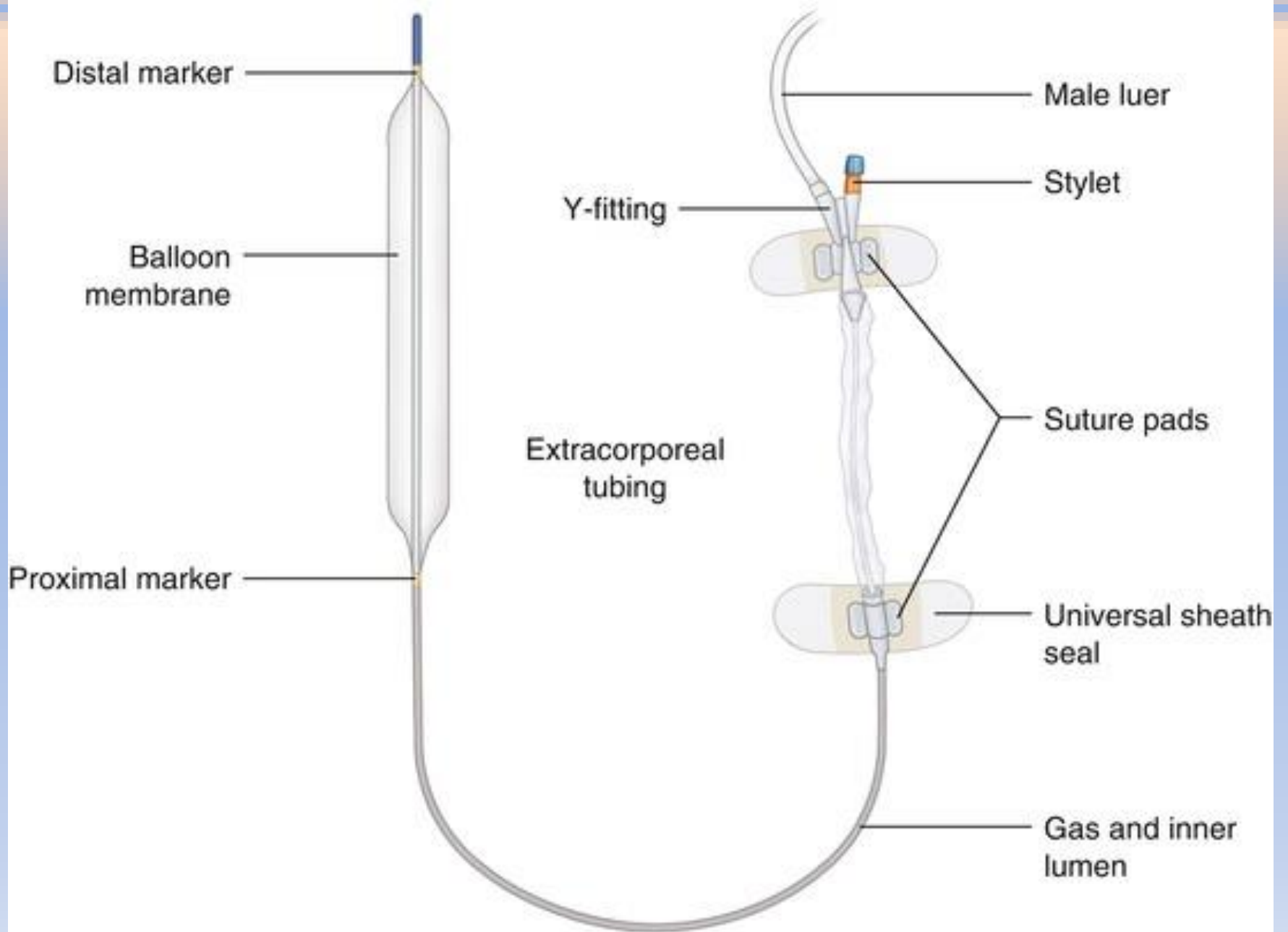
- The balloon is connected to a console that regulates the inflation and deflation of the balloon with the passage of helium.
- **Helium** is used because it is easily dissolved in blood and prevents the risk of air emboli if the catheter ruptures.

# IABP Kit Contents

## Introducer needle

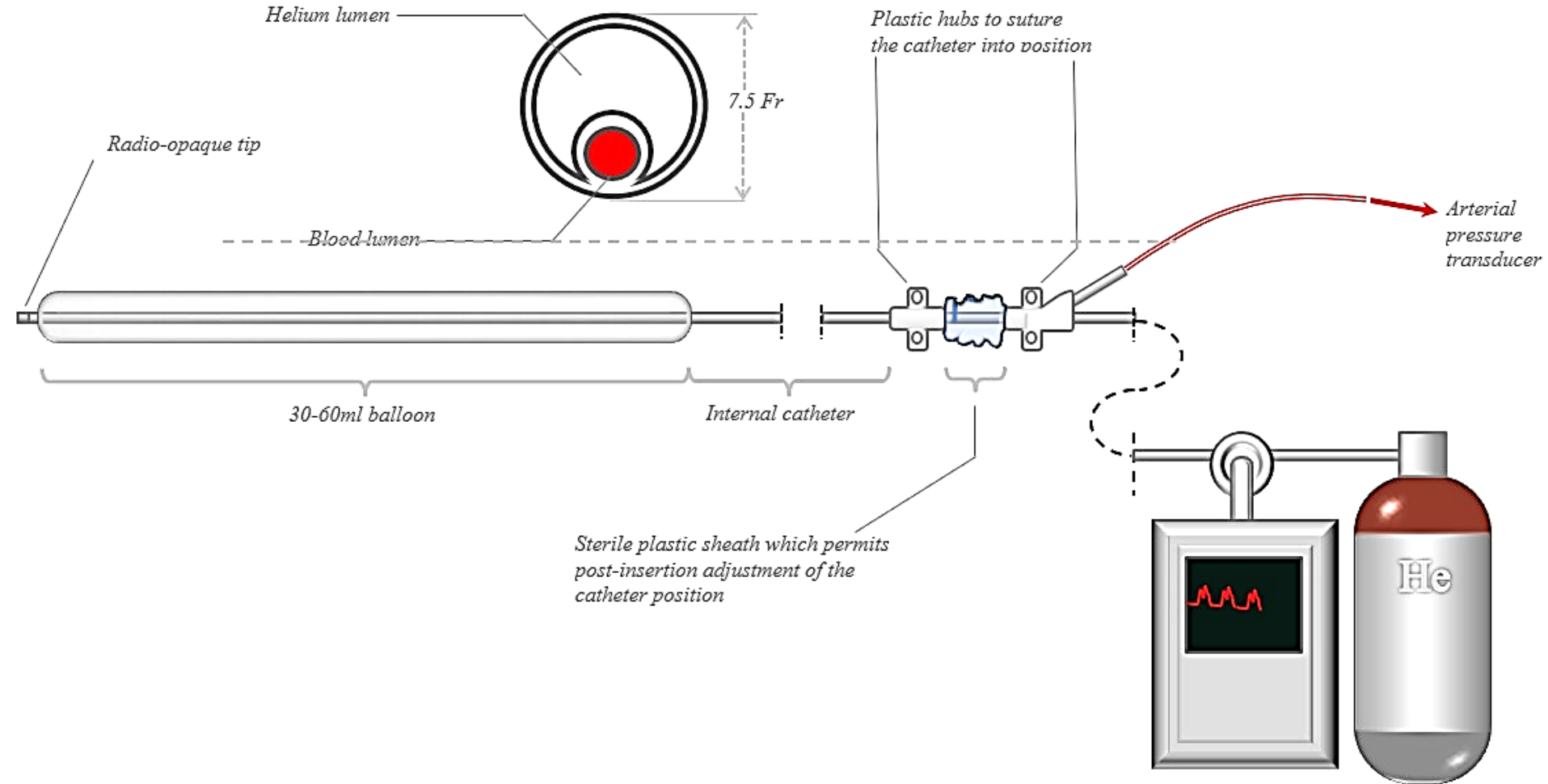
- Guide wire
- Vessel dilators
- Sheath
- IABP (34 or 40cc)
- Gas tubing
- 60-mL syringe
- Three-way stopcock





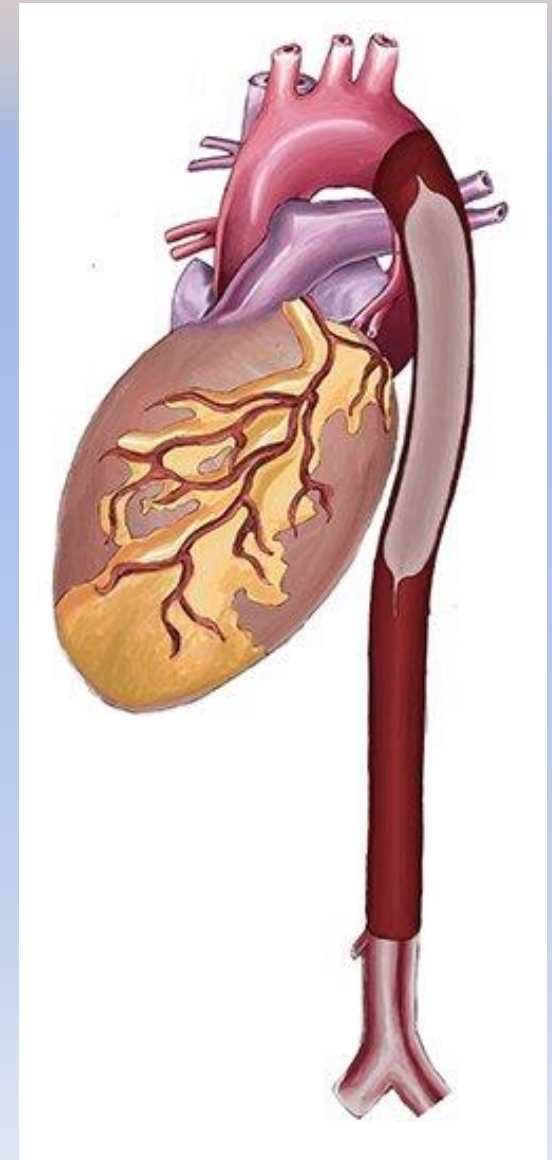
**IABP  
components**

# IAB



# Intra-Aortic Balloon Counter-pulsation

- The word Counter-pulsation stands for **balloon inflation in diastole and deflation in systole.**
- Balloon inflation causes volume shifting or displacement of blood in the whole aorta which means an increase in coronary blood flow and the vascular arterial system may occur



# Effects of IABP

Increase in diastolic pressure



Increase in coronary perfusion



oxygen supply to the heart tissue



# Effects of IABP

Decreasing systolic pressure



Decreased the end diastolic pressure (Afterload)



(Sudden deflation forming a space in the aorta that helps shifting the volume from the left ventricle)



Decrease myocardial oxygen demand

# Effects of IABP

- Decrease heart rate.
- Increase in cardiac output.
- Decreasing systemic vascular resistant
- Decreasing the left ventricle end diastolic pressure.
- Increasing mean arterial pressure, that will lead to an improvement of the perfusion to all organ.
- Reduces mitral valve regurgitation.
- Increases LV ejection

# Effects on other systems

- Increasing renal perfusion and urine output
- Increasing cerebral perfusion
- Increasing respiratory function by decreasing the pulmonary capillary wedge pressure
- Decreasing the systemic vascular resistance

# Insertion of Intra-Aortic Balloon

- Insertion must be performed under sterile technique.
- when deciding to use IAB we must use a suitable size which is provided by the manufacture.
- It depends on the height of the patient to prevent occlusion of the renal arteries

# Intra – Aortic Balloon Size

BALLOON MEMBRANE VOLUME (cc)		PATIENT HEIGHT (cm)
MAQUET	25	<152
	34	152-162
	40	162-183
ARROW	30	147 – 162
	40	162 – 182
	50	>182

# Methods for IABP insertion

## **Percutaneous Insertion:**

- The technique starts by inserting a puncture needle in the picked artery.
- Insert a guide wire then removing the needle and followed by a vessel dilator then using a sheath or not but using a sheath is better in obese patients.
- Insert the balloon which must be deflated using a syringe that comes with the insertion kit upon to the manufacture instructions.

# Methods for IABP insertion

## **Femoral artery cut down insertion:**

- This technique can be used in patients where femoral pulse is not palpable or where difficulty of insertion is anticipated as in patients suffering from peripheral vascular disease(PVD).
- The common femoral artery is isolated through a vertical groin incision and a femoral artery can be dissected.

# Methods for IABP insertion

## **Intra-operatively insertion through Ascending Aorta (Transthoracic Insertion):**

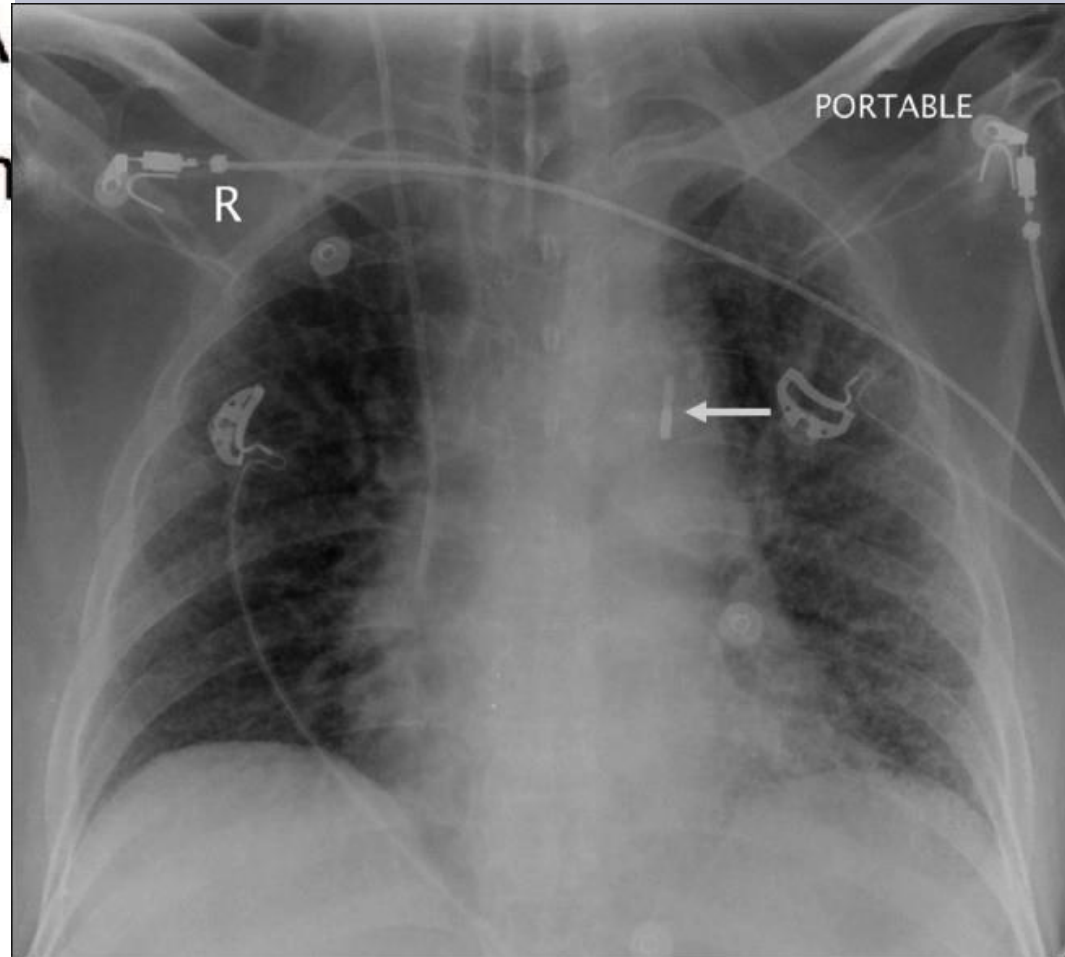
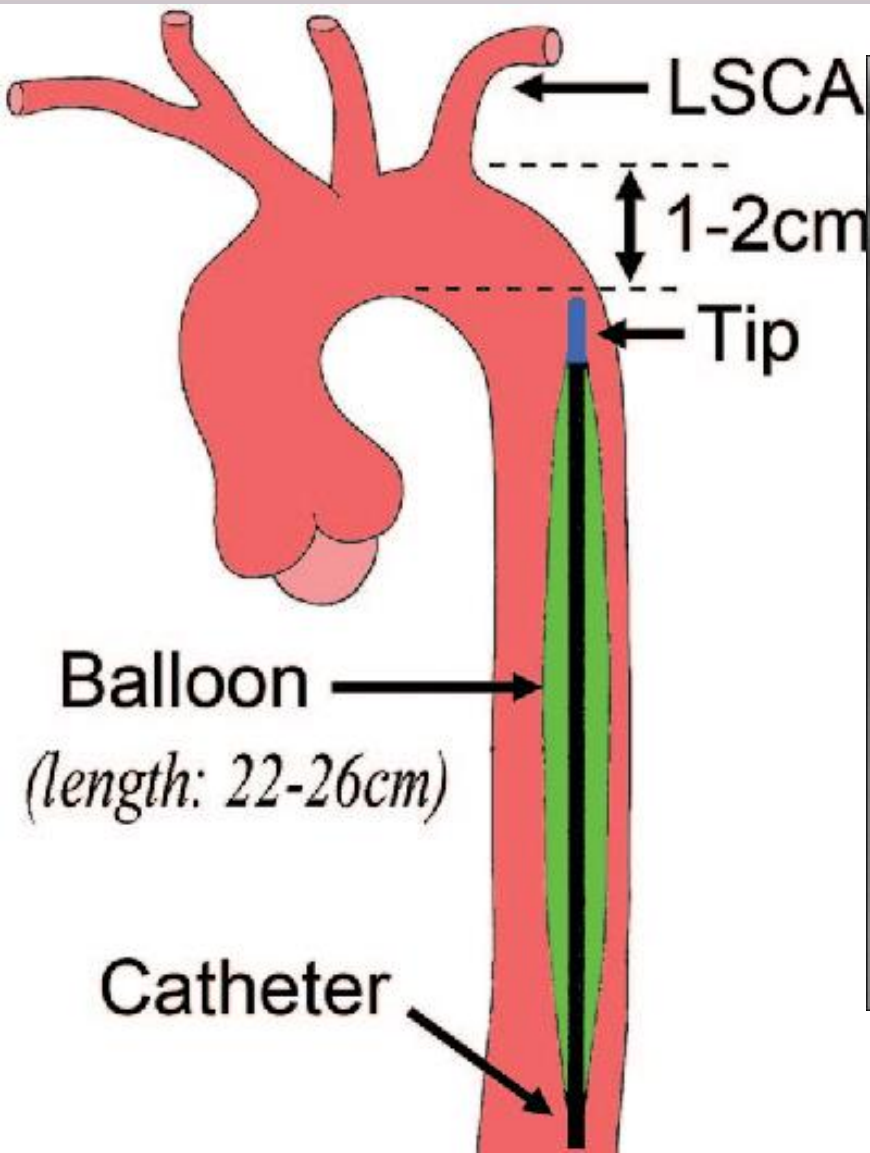
- Due to severe peripheral vascular disease (PVD), the IAB catheter can be introduced down the aorta in operative room situations.



# IABP Position

- The position of the IABP is important and can be assured first from the timing using the pressure wave and then by a chest X-Ray.
- **2 centimeters below the take-off of the left subclavian** artery to prevent occlusion of the subclavian artery, 2cm above the renal artery.
- On chest Xrays, **the tip** should be **visible between the 2<sup>nd</sup> and 3<sup>rd</sup>** intercostal space.

# IABP Position



# Preparations

- After the decision to use a IABP is made the first step is to prepare the patient.
- The next step is to prepare the balloon.
- First ensure that the balloon has negative pressure applied with one way valve in place.

# Preparations

- The IABP must be prepared for operation before connecting the IAB
- The first item is power plug the pump into electrical outlet
- Turn the helium on & ensure that the tank has adequate supply

# Preparations

- The next step is to obtain ECG signal.
- This can be done by either attaching leads to the patient or slaving a signal from monitor
- Next setup and prime the transducer.
- The transducer and one end of the monitoring line are passed off the field while the end that attaches the IAB is kept on the field and sterile

# Preparations

- Now it is attached to IABP ,primed and zeroed, while the end attached to IAB remains sterile on operative field.
- Once the EKG signal is acquired and transducer is connected, zeroed and the monitor line flushed, the IABP is ready to connect to IAB that has been placed in patient
- The gas line is connected to the balloon and other end to the IABP

# Augmentation of Intra-Aortic Balloon

- **The balloon augmentation is the amount of helium in the balloon catheter.**
- It can be controlled via the balloon pump console.
- Make sure that the balloon is fully augmented (inflated by a full amount of helium), this will assure that the balloon is shifting the right amount of blood volume.
- Prevent formation of clots which may occurs by the sides of the balloon if not fully inflated.

# Triggers of IABP

**Five methods can be used:**

- **ECG:** using **R wave** on the ECG to start pumping.
- **Pressure wave :** the **dicrotic notch** in the arterial pressure wave is used to initiate inflation.
- **Internal:** The balloon inflates and deflates at a preset rate regardless of the patient's cardiac activity. This mode is only to be used in situations where there is no ECG and no cardiac output , such as cardiopulmonary bypass(Operator mode). The balloon inflates and deflates by **internal rate** with range between 40 and 120 beats/min.
- **Pacer V/AV:** uses **spikes of the ventricle** that been generated by pacing box.
- **Pacer A:** uses the **atrial pacing spike** as the trigger signal.



# Timing of IABP

- **Timing** is relationship between the balloon inflation and deflation ,and the heart systole and diastole.
- The timing is to have the right time of inflation at the closure of the aortic valve and deflation at the early systole.
- ***Inflation at the closure of the aortic valve***
- ***Deflation at the early systole***

# Timing of IABP

- The inflation ratio refers to the number of balloon inflations to the number of QRS complexes and can be set at 1:1, 1:2 or 1:3

# Inflation

- Balloon inflation occurs at the beginning of **diastole**, after aortic valve closure, immediately after **peak T wave** in the ECG (during isovolumetric relaxation), which can be seen in the pressure waveform just prior to the **dicrotic notch** (lies at or slightly above the dicrotic notch).

# Deflation

- (helium is transferred back from the balloon to the tank) balloon deflation occurs **just before the systole** ,before aortic valve open.
- In the ECG the deflation appear on **peak of R wave** (during isovolumetric contraction).
- ***The effectiveness of IABP augmentation is reduced when there is excessive tachycardia (>120 bpm) or cardiac arrhythmia.***

Figure 10:9

# Proper Timing of IAPB



## Inflation

PDP > PSP

IP = DN

IP = V shape

## Deflation :

PSP > APSP

BAED < PAEDP

BAEDP = V shape

## Assisted Arterial Waveform (1:2)

Modified from Arrow International: <http://www.arrowintl.com/documents/pdf/education/ttb-m0701.pdf>

**PAEDP** : Patient's Aortic End Diastolic Pressure.

**PSP**: Peak Systolic Pressure .

**PDP**: Peak Diastolic Pressure ( **DA** :Diastolic Augmentation) .

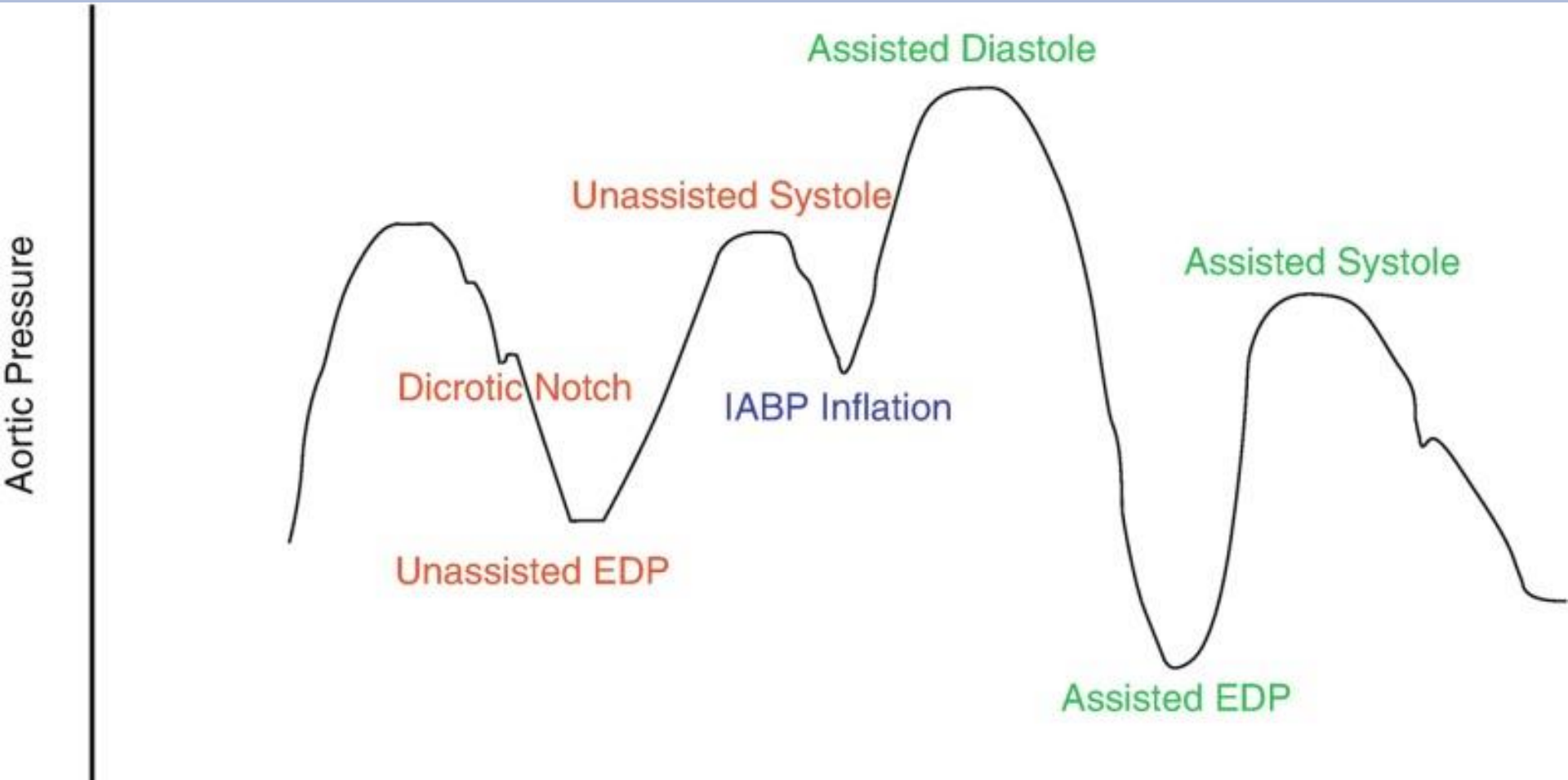
**APSP**: Assisted Peak Systole Pressure .

**BAEDP**: Balloon Aortic End Diastolic Pressure .

**DN** : Dicrotic Notch.

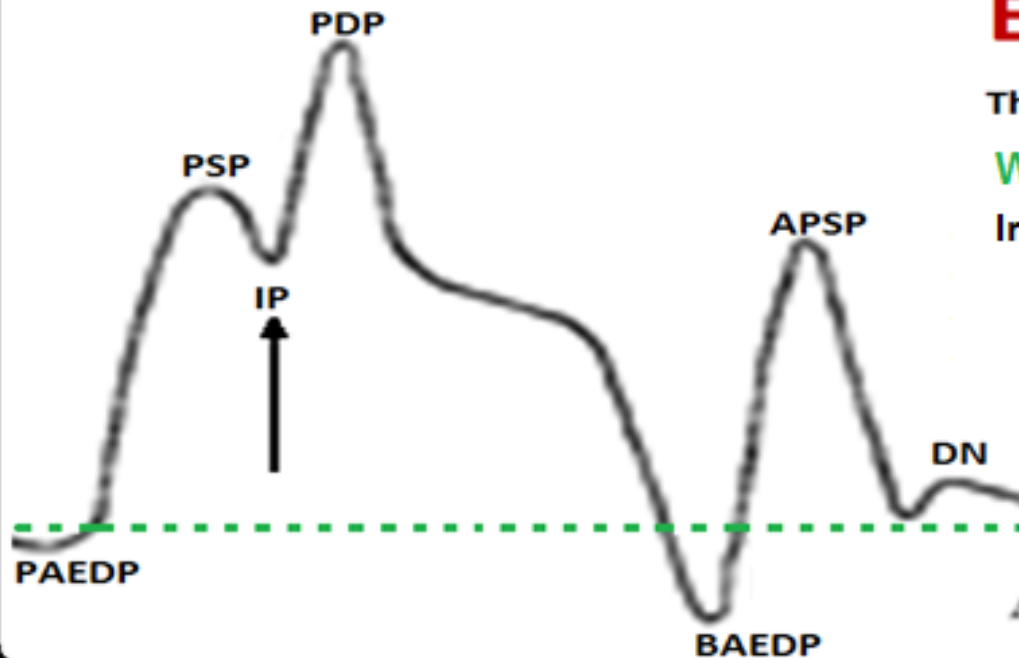
**IP** : Inflation Point.

# Timing in IABP



# Common Timing Errors

Figure 10:10



## Early inflation

The inflation occur before the dicrotic notch

### Waveform Characteristics:

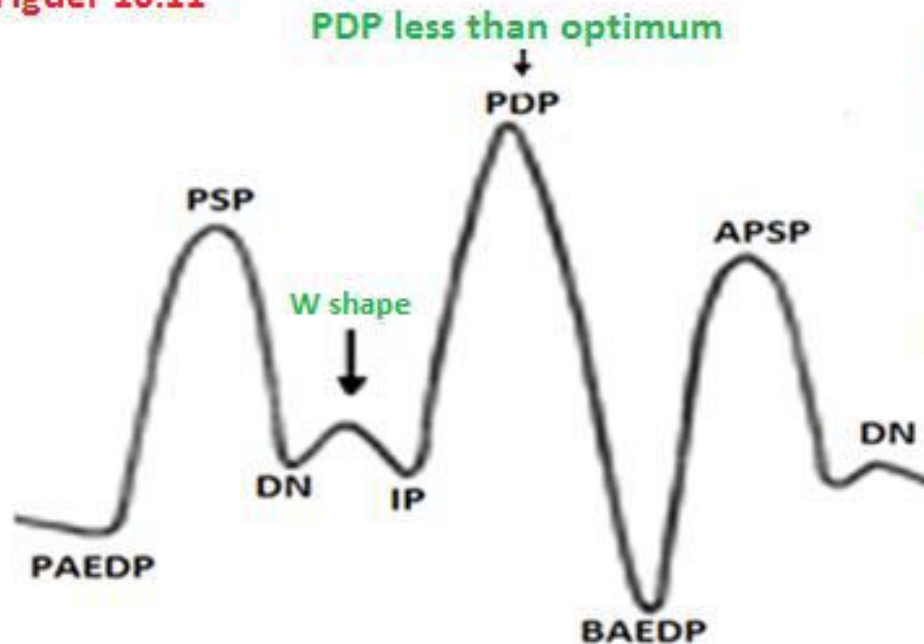
Inflation point above the level of dicrotic notch

### Physiologic Effects:

- ❖ Premature closure of aortic valve
- ❖ Reduces stroke volume/CO
- ❖ Increase in Preload (LVED volume)
- ❖ Increase in LV wall tension
- ❖ Increased Afterload

## Arterial Waveform (1:2)

Figuer 10:11



## Late inflation

The inflation occurs after the dicrotic notch

### Waveform Characteristics:

The inflation point occurs after the dicrotic notch  
Inflation point create a W shape  
PDP Less than optimum

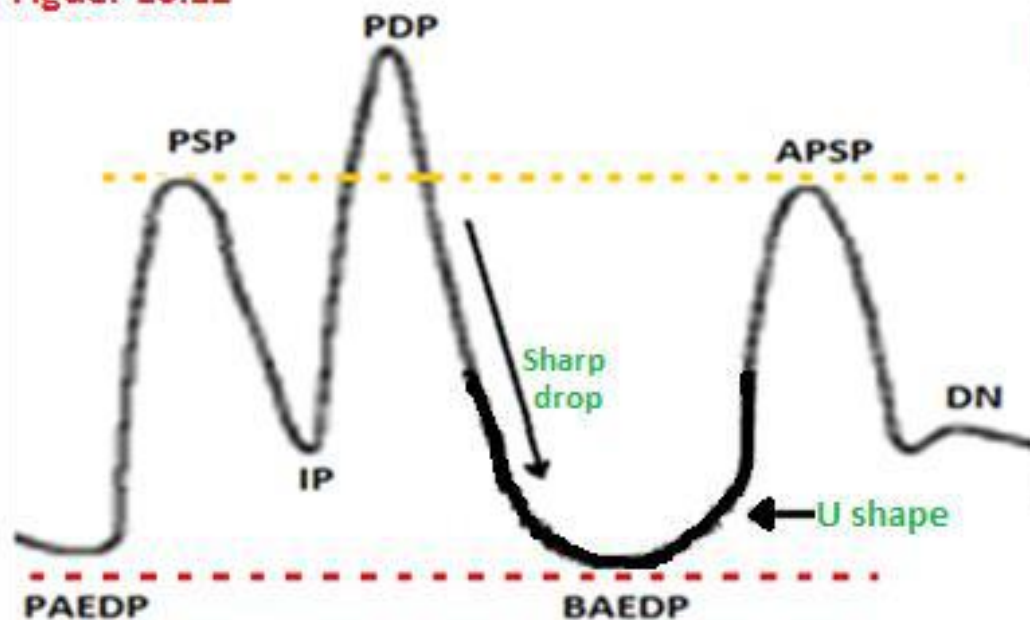
### Physiologic Effects:

- ❖ Peak systolic pressure less than optimum.
- ❖ Decreased perfusion pressure and volume to coronary arteries.

## Arterial Waveform (1:2)



Figuer 10:12



## Early deflation

The balloon deflates early in diastole.

### Waveform Characteristics:

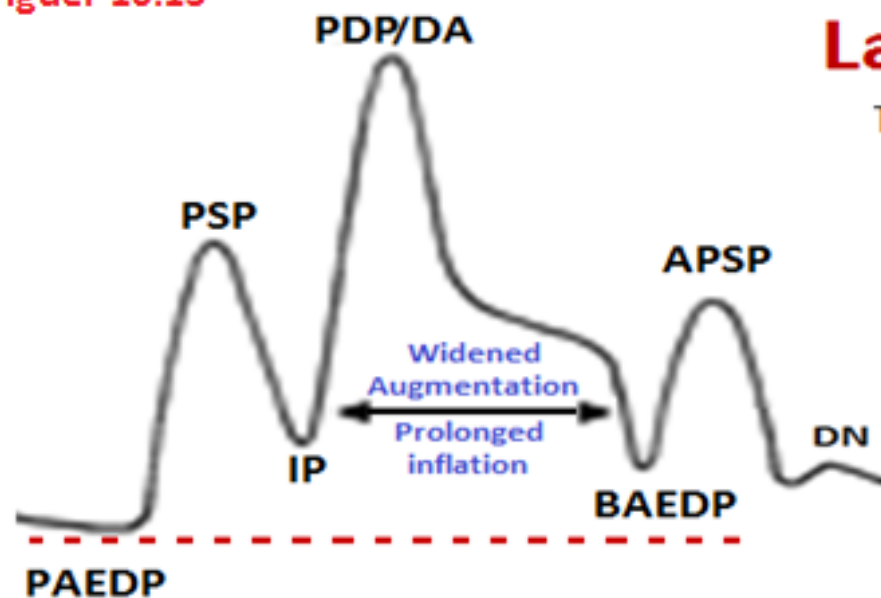
- U shape appears at BAEDP.
- $PSP \geq APSP$ .
- Sharp drop following PDP.
- $PAEDP \approx BAEDP$ .

### Physiologic Effects:

- ❖ No afterload reduction.
- ❖ No myocardial oxygen demand reduction.

## Arterial Waveform (1:2)

Figuer 10:13



## Late deflation

The balloon has been inflated too long.

### Waveform Characteristics:

**BAEDP > PAEDP**

**Diastolic augmentation(DA) appear widened**

### Physiologic Effects:

- ❖ Increasing afterload
- ❖ Increasing myocardial oxygen consumption
- ❖ Increasing cardiac workload
- ❖ Increasing preload

**Arterial Waveform (1:2)**

# Common Timing Errors

- EARLY INFLATION - Inflation of IAB before aortic valve closure.
- LATE INFLATION - Inflation of IAB after closure of aortic valve.
- EARLY DEFLATION - pre matured deflation during diastolic phase.
- LATE DEFLATION - Deflation after the onset of systolic.

# Weaning of IABP

- Intra-Aortic Balloon generally improves the cardiac function within 1-3 days at which time the IABP can be removed.
- Firstly, the IABP augmentation can be reduced to 50% for 2–4 hours.
- The inflation ratio is then progressively reduced from 1:1 to 1:2 for another 2–4 hours and then to 1:3
- observing the patient hemodynamics before the balloon catheter is removed.

# Weaning of IABP

- The IABP must be switched off and the catheter completely deflated just prior to removal.
- Heparin should be discontinued at the start of IABP weaning so that coagulation is normalized by the time the IABP catheter is removed.

# Removal of IABP

- Carefully remove dressing from insertion site. Remove all sutures and ties anchoring catheter to skin.
- Switched off IABP and disconnect helium line from control system .
- Remove the balloon
- After remove the balloon, allow free flow of blood to flush puncture site for several seconds.

# Removal of IABP

- Apply firm pressure to site for 30 minutes, or until hemostasis has been achieved.
- During and after removal, check distal pulses frequently and assess for signs of complications.

THANK YOU