IABP

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Lecturer

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???

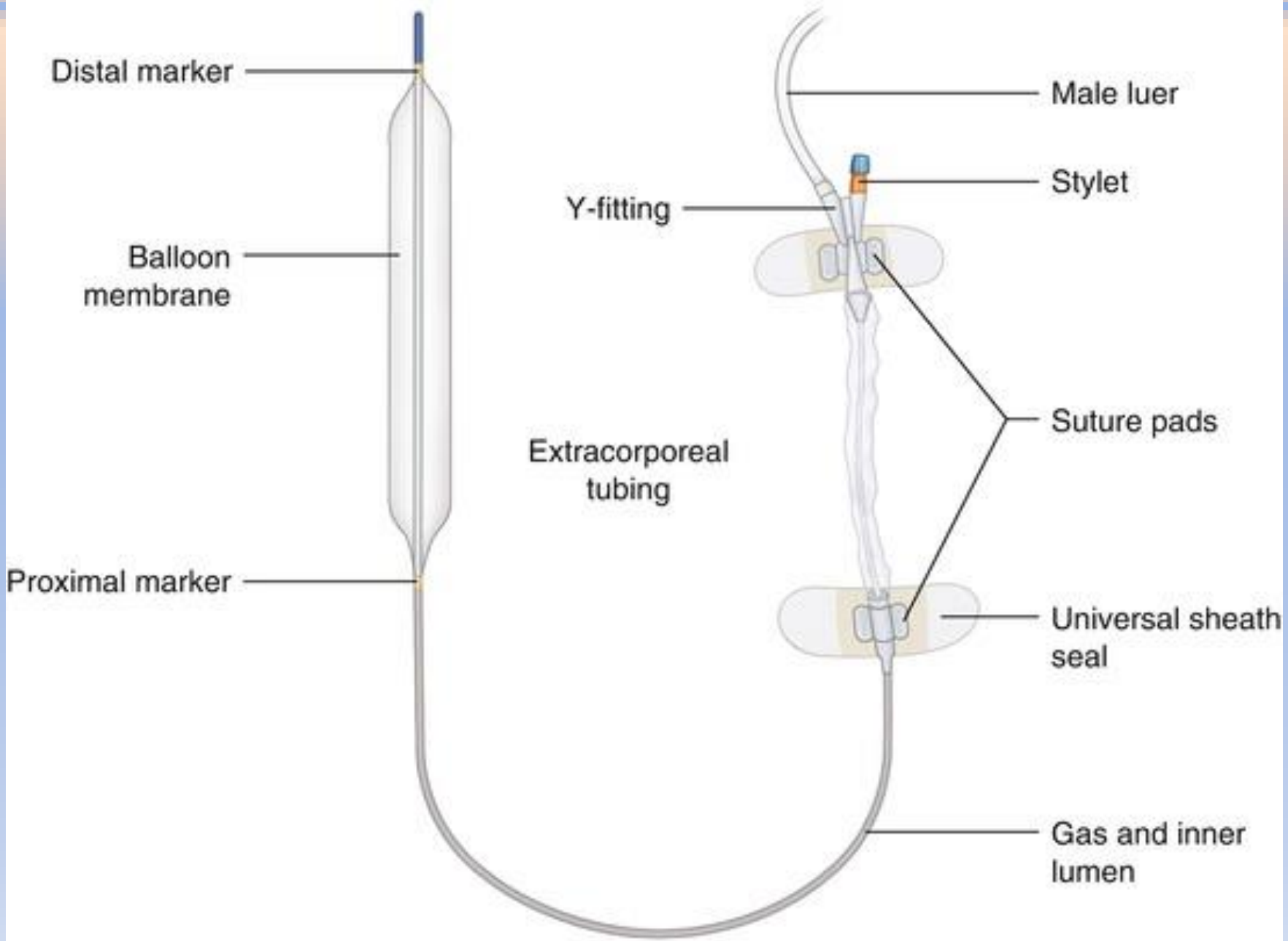
- The balloon is connected to a console that regulates the inflation and deflation of the balloon with the passage of helium.

- **Helium** is used because it is easily dissolved in blood and prevents the risk of air emboli if the catheter ruptures.

IABP Kit Contents

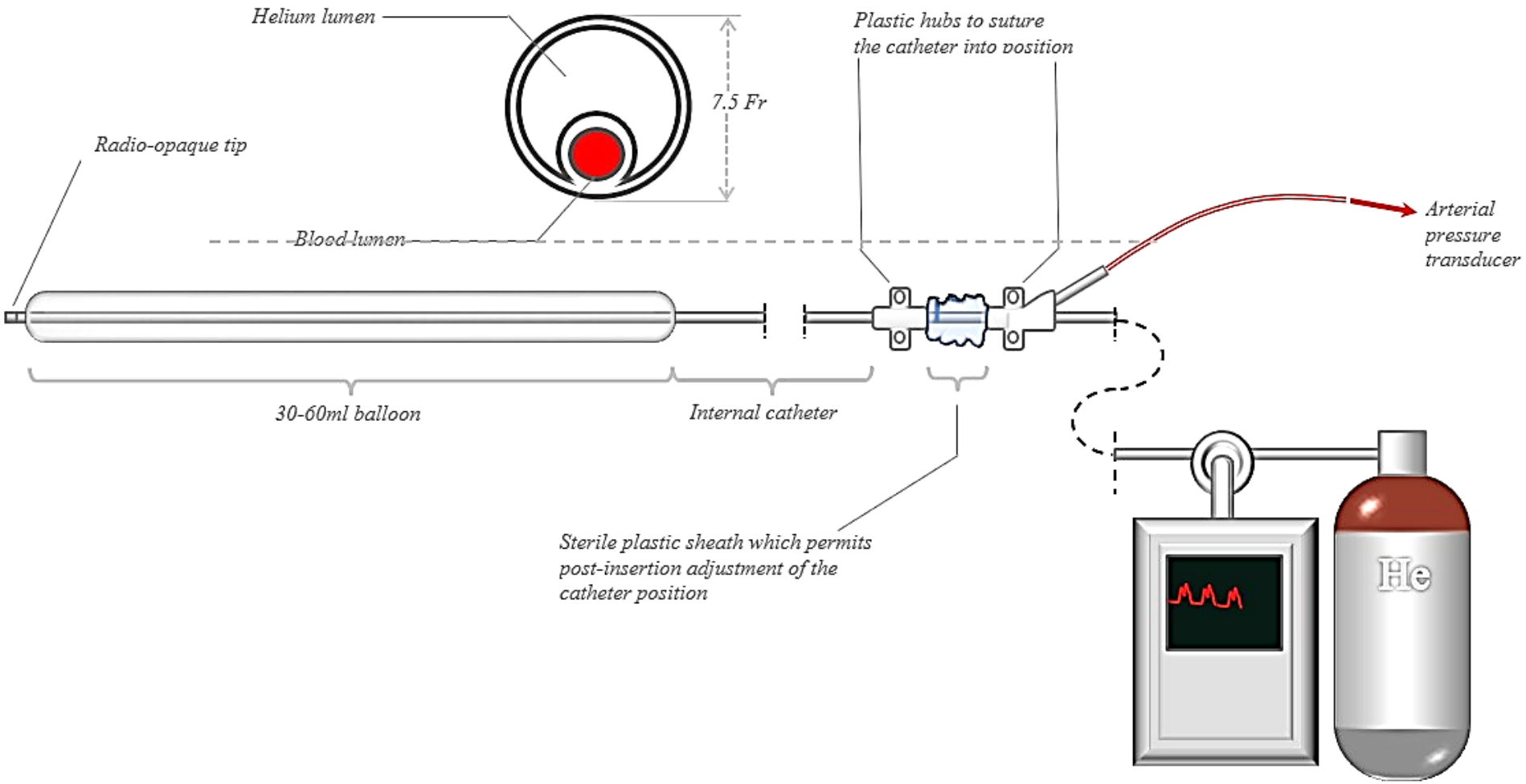
Introducer needle

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



IABP components

IAB


Helium lumen
7.5 Fr
Plastic hubs to suture the catheter into position
Radio-opaque tip
Blood lumen
Arterial pressure transducer
30-60ml balloon
Internal catheter
Sterile plastic sheath which permits post-insertion adjustment of the catheter position
He

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 sheet or not but using a sheet 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.

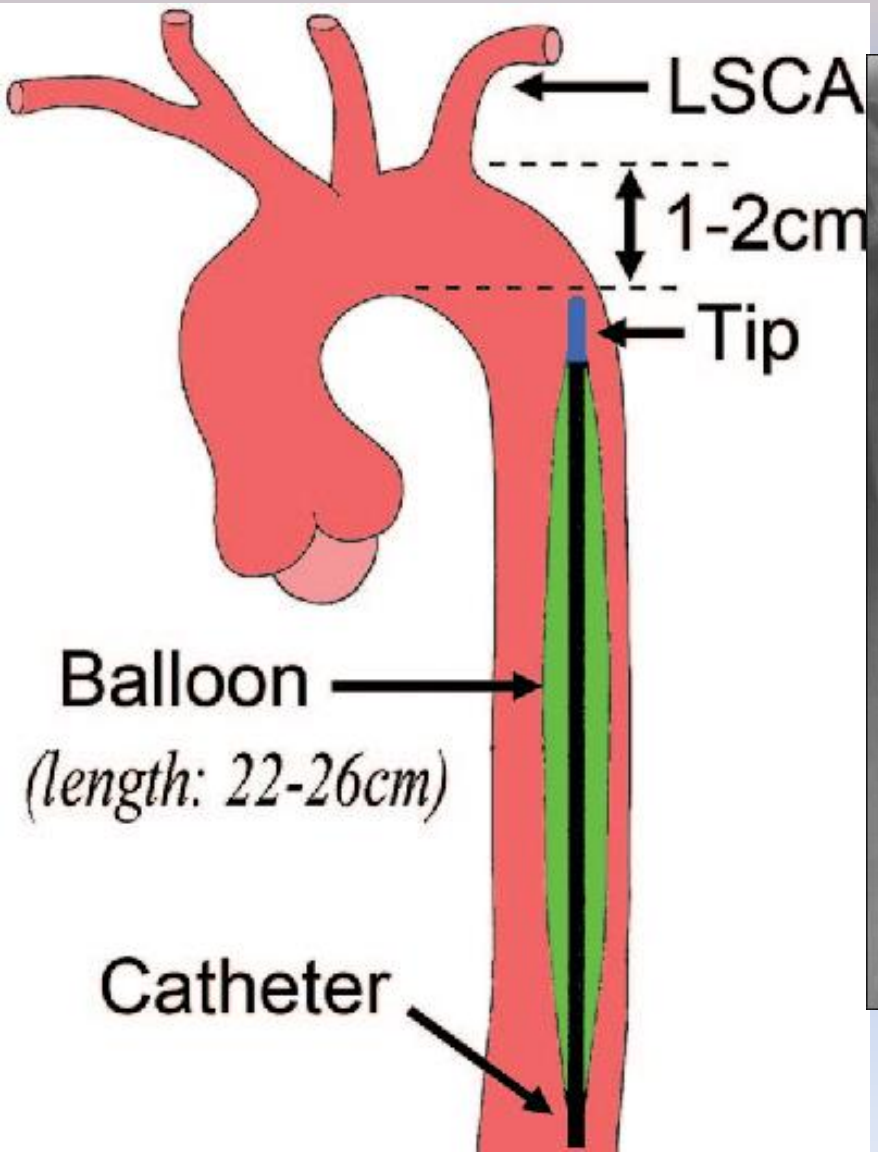
IABP Position

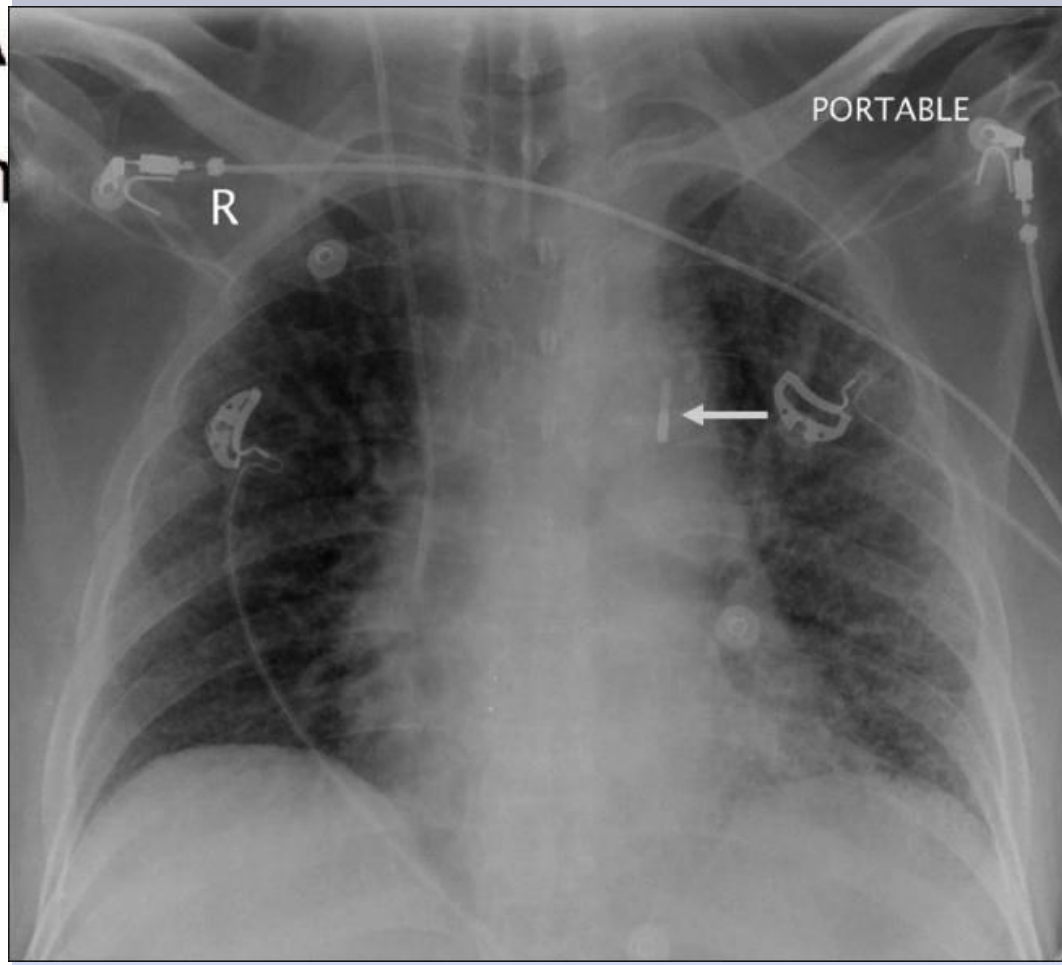
- The position of the IABP is important and can be assured first from the timing using the pressure wave and then by a chest X-Ray.

- **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 2nd and 3rd** 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

Assisted Arterial Waveform (1:2)

Inflation

PDP>PSP

IP =DN

IP =V shape

Deflation :

PSP>APSP

BAED<PAEDP

BAEDP= V shape

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) .

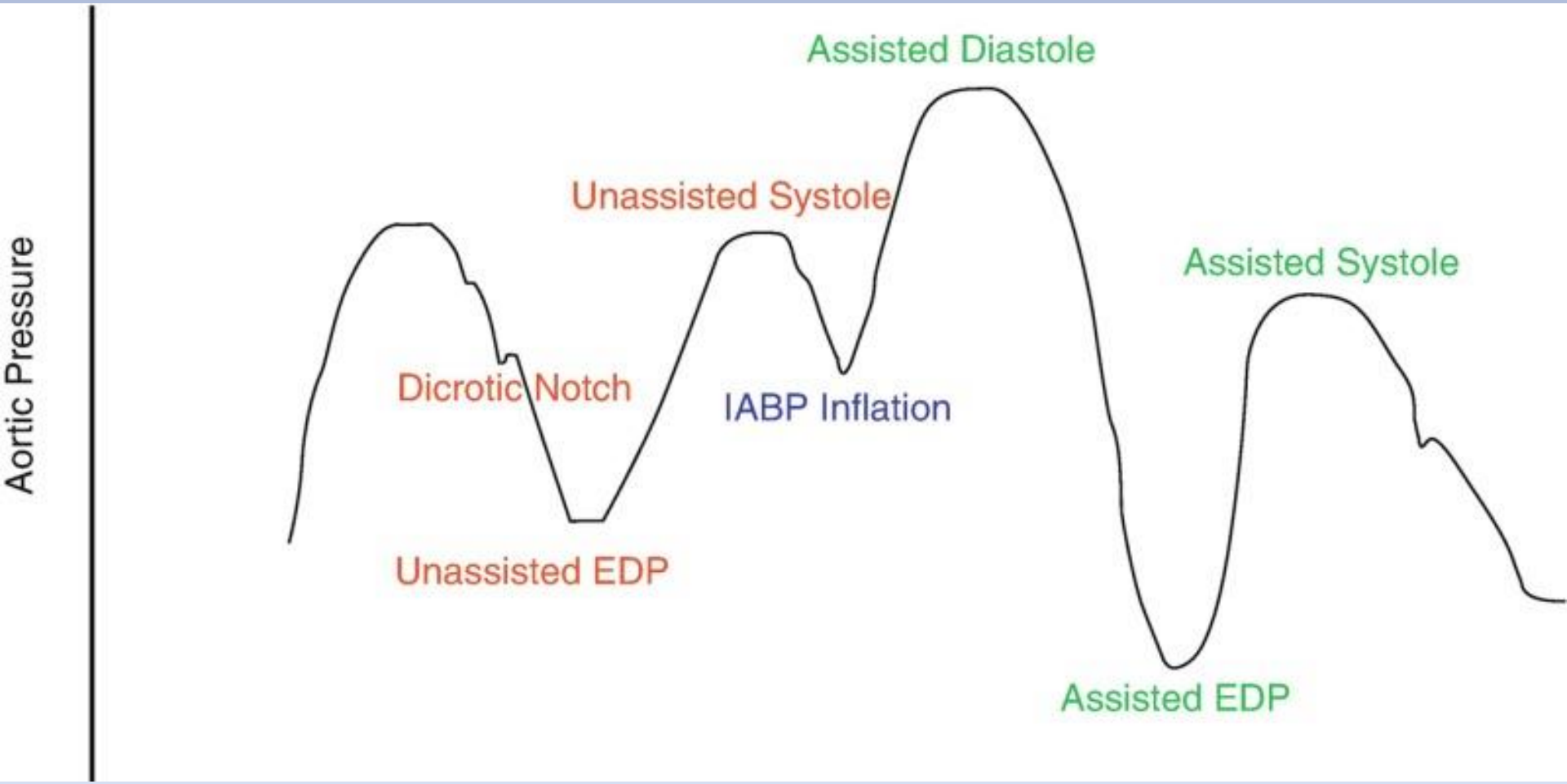
APSP: Assisted Peak Systole Pressure .

BAEDP: Balloon Aortic End Diastolic Pressure .

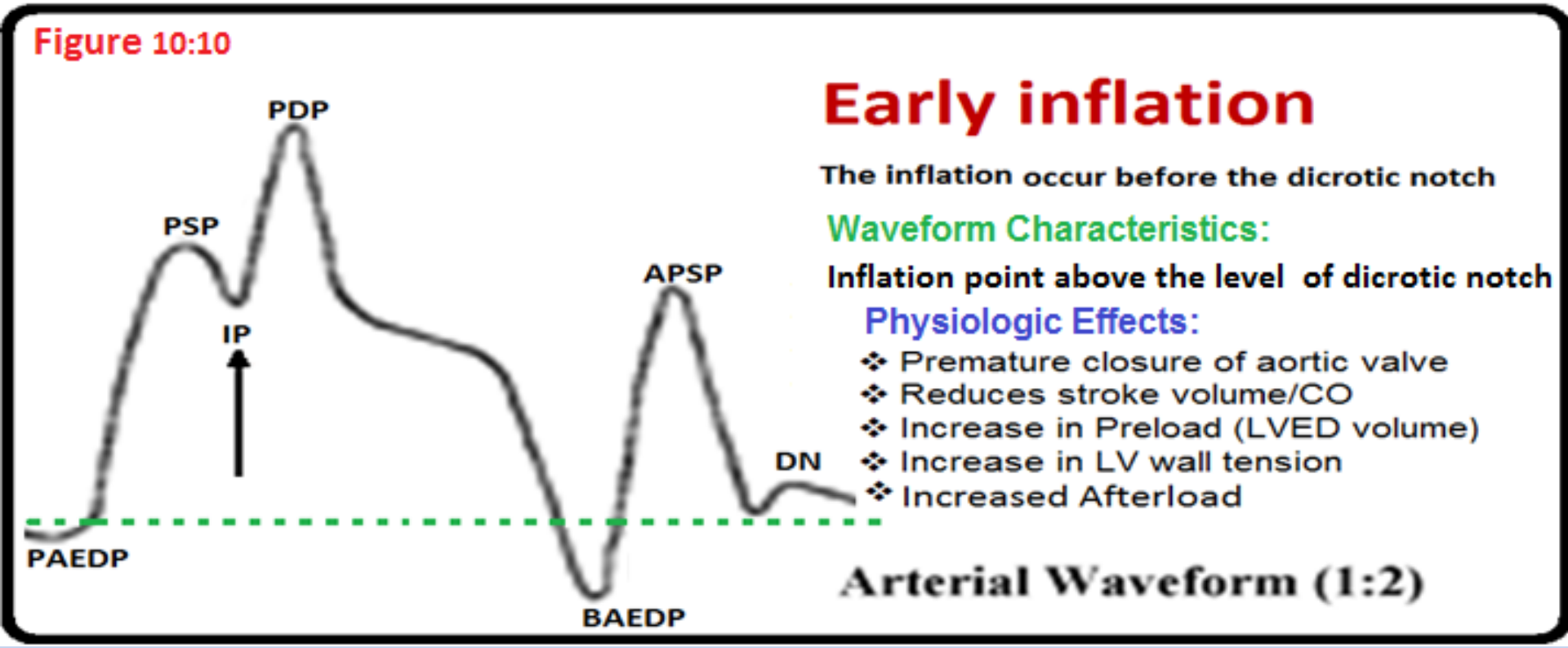
DN : Dicrotic Notch.

IP : Inflation Point.

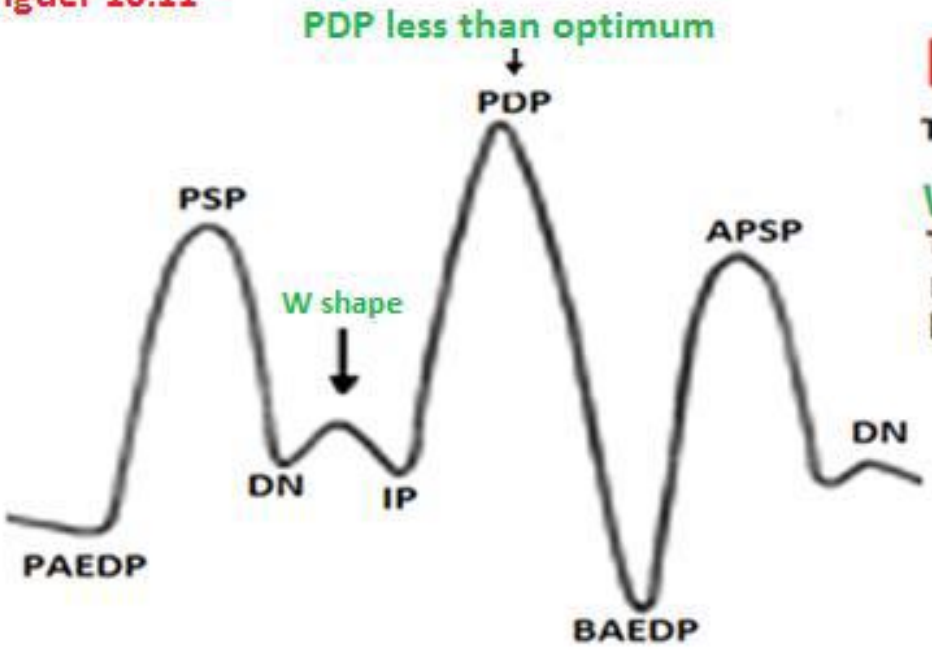
Timing in IABP



Common Timing Errors



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

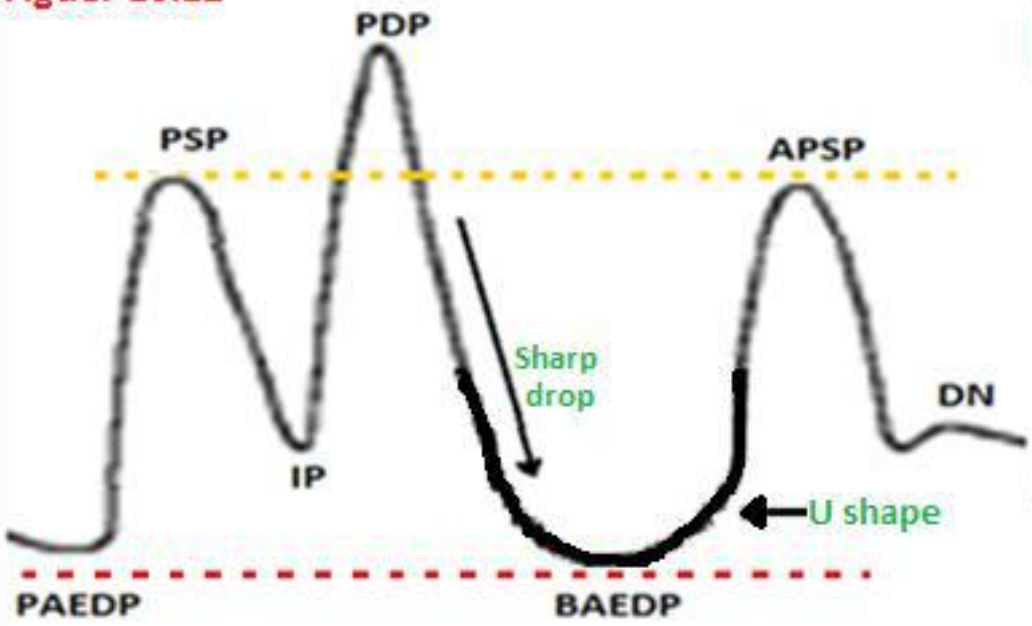
PDP Less than optimum

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:

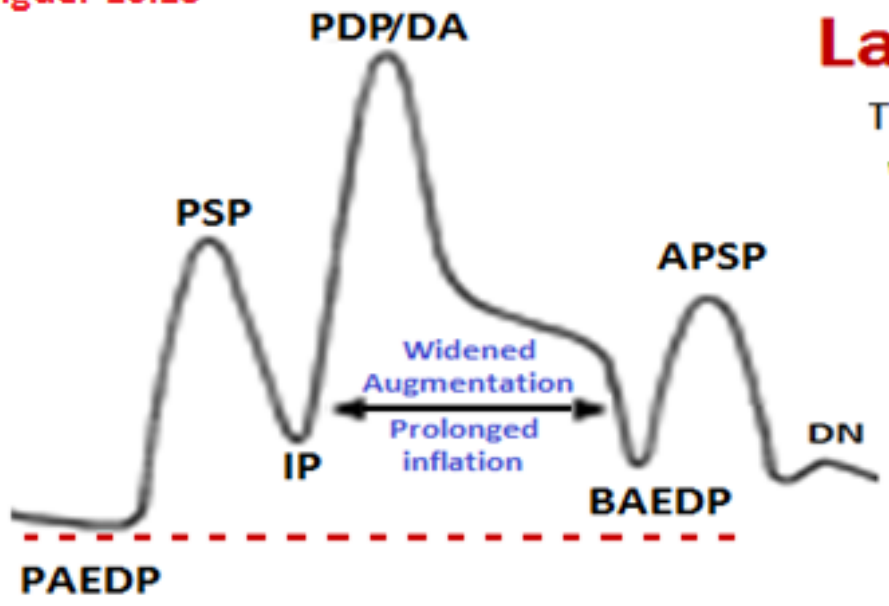
U shape appears at BAEDP.
PSP ≥ APSP.
Sharp drop following PDP.
PAEDP ≈ BAEDP.

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 to1:3
- 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