Intra Aortic Balloon Pumps

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Indications for Use

- Cardiogenic Shock secondary to acute MI
- Mechanical complications of Acute MI (e.g. MR & VSD)
- Decompensated Systolic Heart Failure (only as a bridge to definitive treatment)
- Refractory unstable angina
- Refractory ventricular arrhythmias

Indications cont.

- Also used peri - operatively for high risk Coronary Artery Bypass surgery.
- Decompensated Aortic Stenosis

How does it work?

Intra-aortic balloon pump therapy is used to improve coronary artery perfusion and to decrease left ventricular afterload. A specialised arterial catheter, which has a helium filled balloon is inserted percutaneously into the descending aorta. This catheter is attached to the IABP which pumps helium into the balloon during ventricular diastole (thereby increasing myocardial perfusion) draws back the helium prior to ventricular systole (thereby decreasing ventricular afterload).

Balloon Placement

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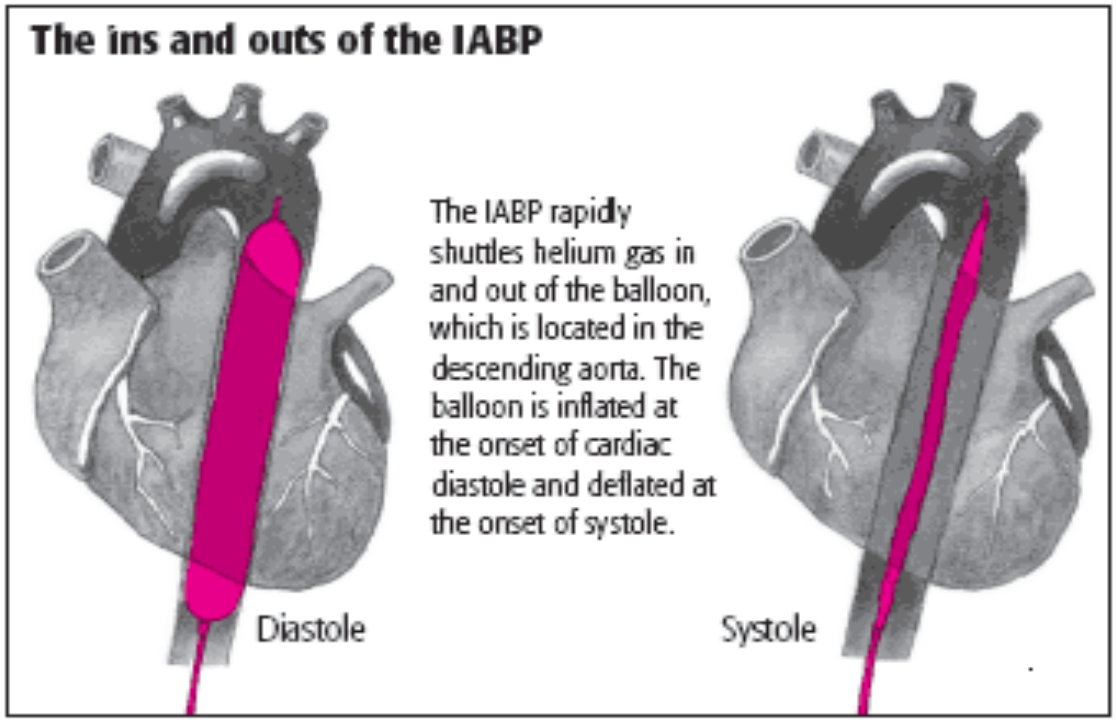
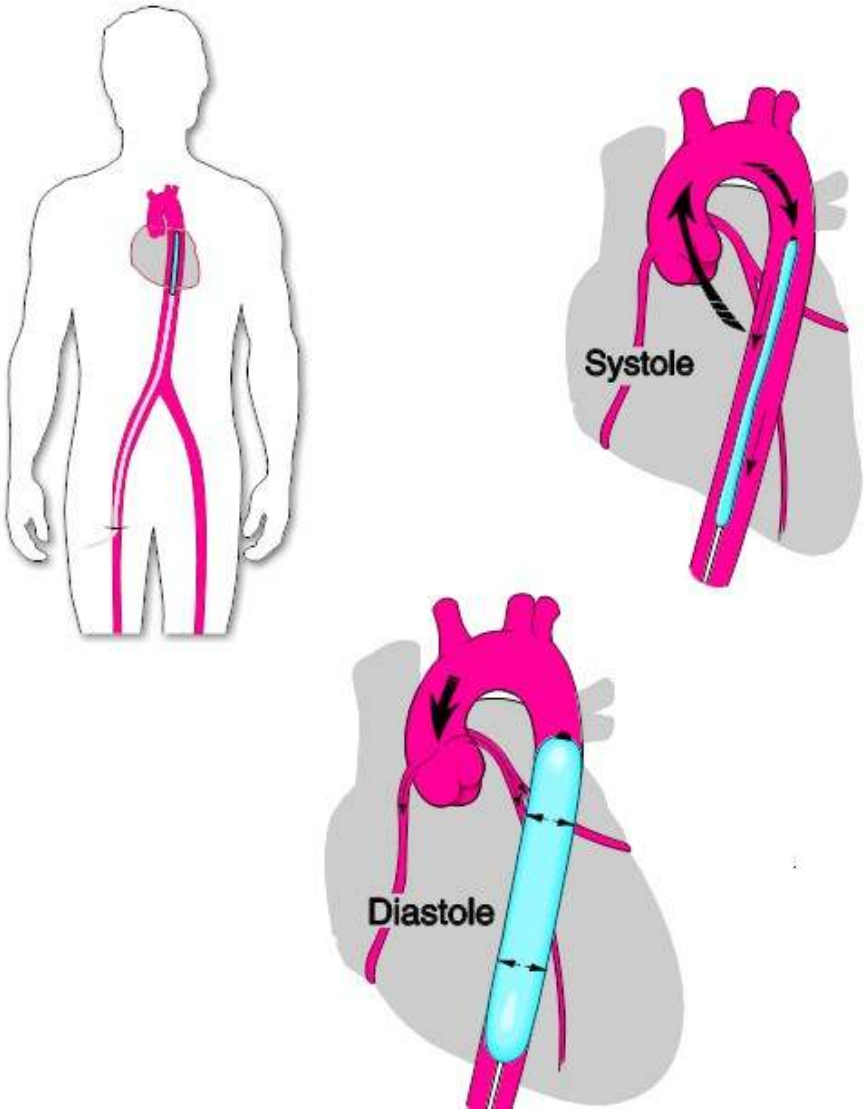
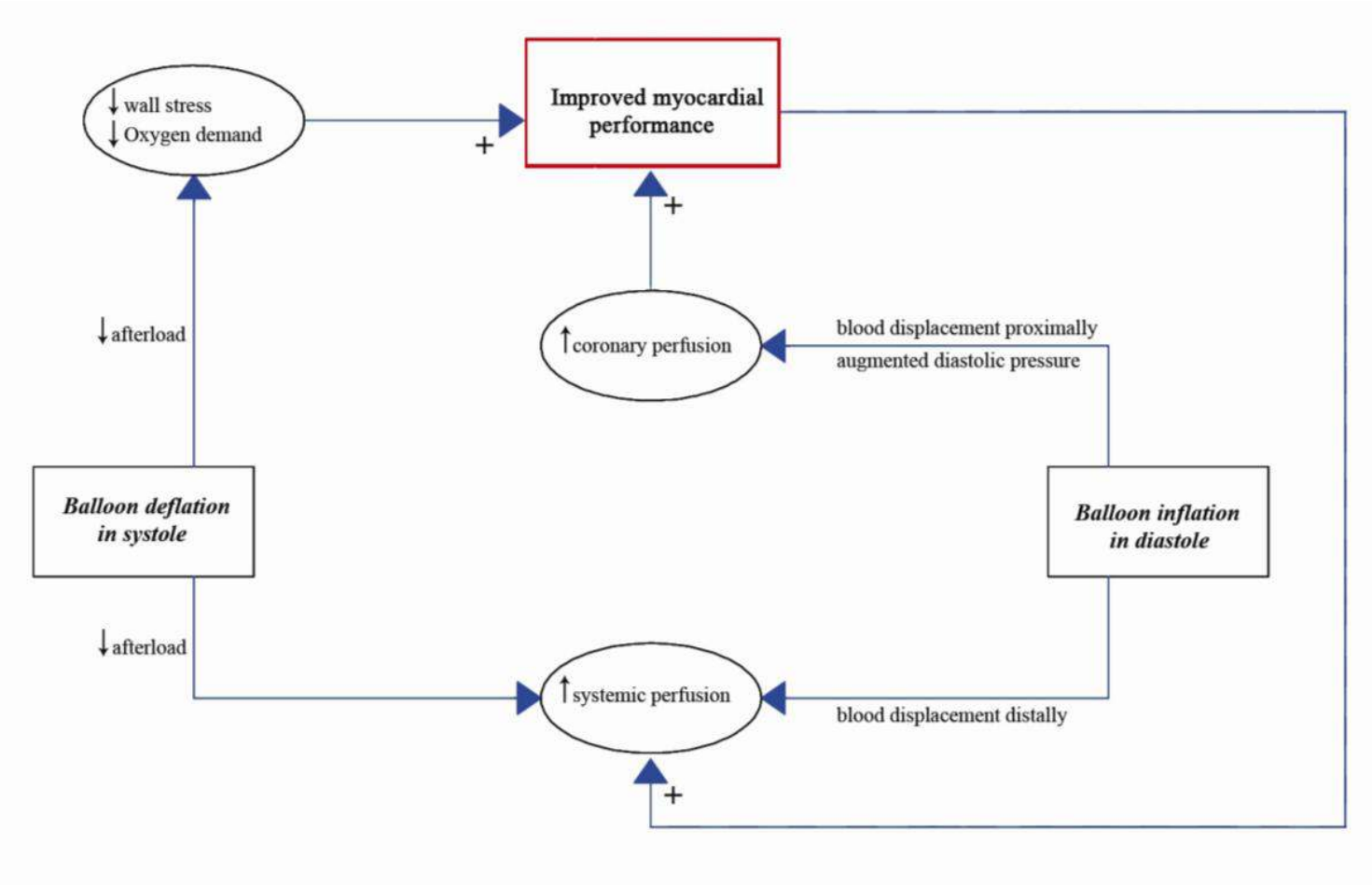


Intra-Aortic Balloon Pump



The concept

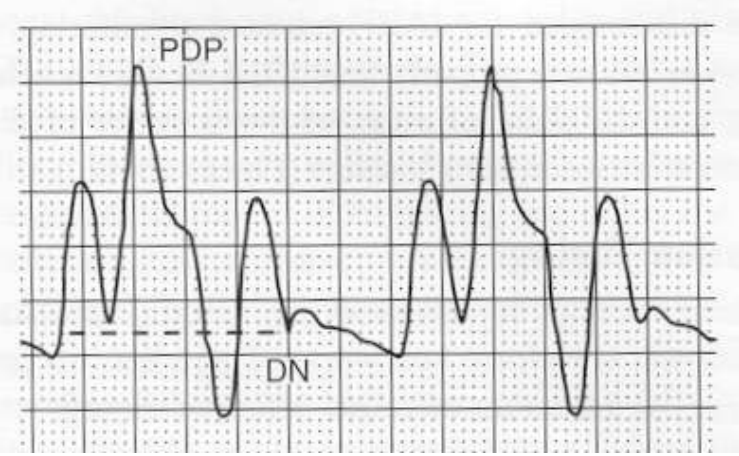
Synchronized counterpulsation is the core principle of IABP therapy. This describes inflation in diastole and deflation in systole of a balloon situated in the descending aorta. The overall aim is to improve myocardial function by increasing myocardial oxygen supply and decreasing myocardial oxygen de-mand. The method by which this is achieved is by displacement of blood in the aorta, both proximally and distally during balloon inflation.


↓wall stress
↓Oxygen demand
Improved myocardial performance
+
+
↓afterload
↑coronary perfusion
blood displacement proximally
augmented diastolic pressure
Balloon deflation in systole
Balloon inflation in diastole
↓afterload
↑systemic perfusion
blood displacement distally
+

Timing

- For the IABP to “pump” effectively, two waveforms need to be set. The ECG signal to “trigger” the balloon and the arterial pressure signal to “time” the counterpulsation. The arterial waveform, a less reliable trigger, uses the systolic upstroke.
  - The trigger allows the pump to identify the start of the cardiac cycle.
  - The pump looks for the “R” wave to signal the onset of systole
  - If an ECG is unreliable, the arterial pressure waveform can be used as a trigger whilst the ECG trace is optimised.
  - Once the trigger is set, the arterial pressure waveform displayed on the console is used to assess timing and the effectiveness of pumping.

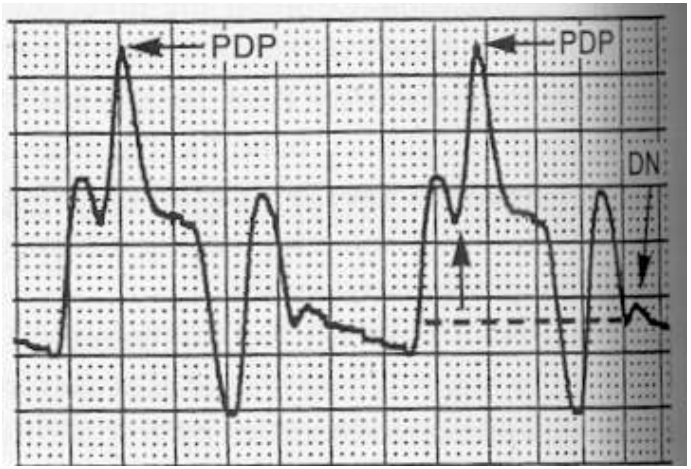
- Timing: Set the mode to 1:2
  - Compare the unassisted cardiac cycle with the assisted (augmented) cycle.
    - There is a sharp “V” on the waveform at the dicrotic notch (DN). The dicrotic notch is when the aortic valve closes – this is the point at which the intra-aortic balloon starts to inflates.



- Inflation of the balloon is timed to occur at the dicrotic notch (aortic valve closure) on the arterial pressure tracing.
- As the balloon inflates and the pressure rises there will be an upward deflection following the dicrotic notch, referred to as diastolic augmentation and represents the pressure produced early in diastole by the inflated balloon.
- Because inflation increases pressure in the aorta, the peak of diastolic augmentation is higher than the peak of systole.
- As the balloon deflates the assisted aortic end diastolic pressure (pressure in the aorta) at the end of diastole – dips down to create a "U" or "V" shaped wave form.

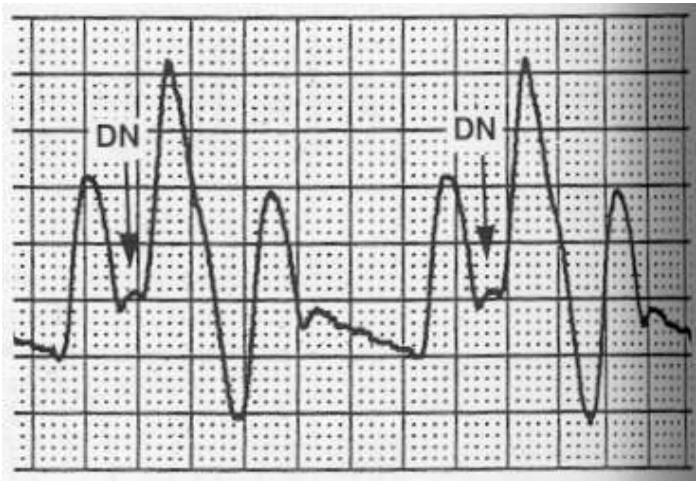
Early Inflation

- In **early balloon inflation**, the upstroke *(arrow)* of peak diastolic pressure occurs approx 9 little squares before the onset of systole.



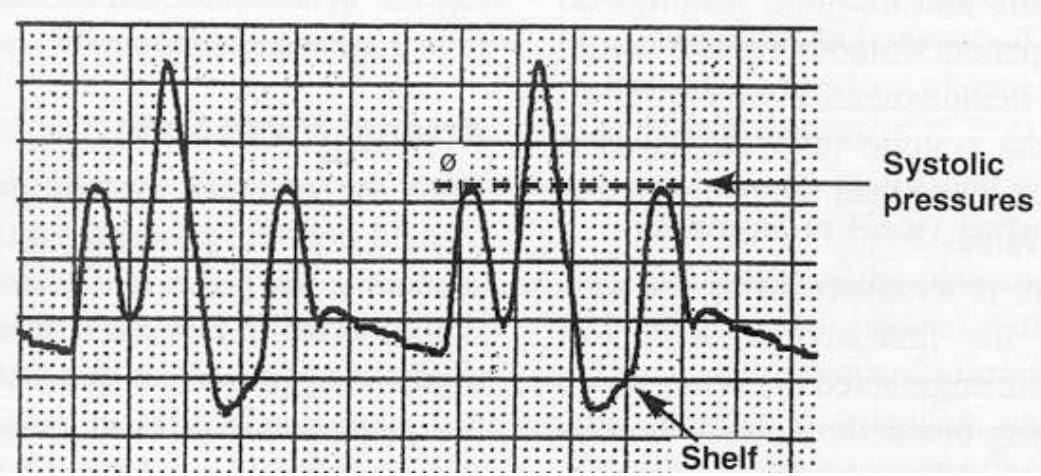
Late inflation

- In **late balloon inflation** a significant portion of the diacrotic notch (*arrows*) is visible.



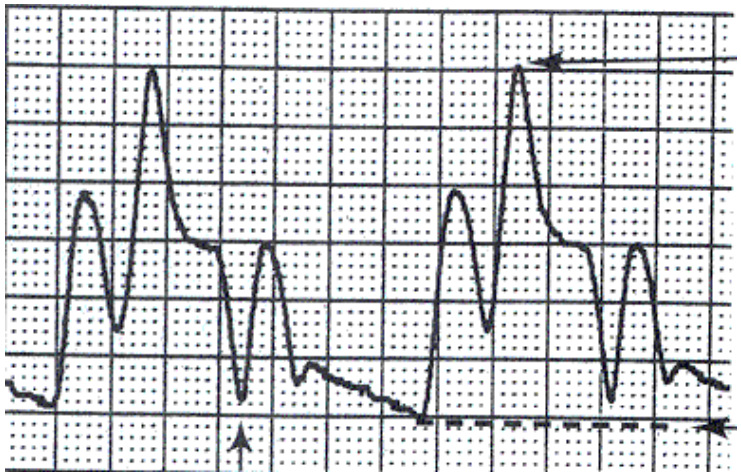
Early deflation

- In **early deflation,** note the U shape rather than V shape of the waveform and indication of a brief shelf (*arrow*) before the next systole.

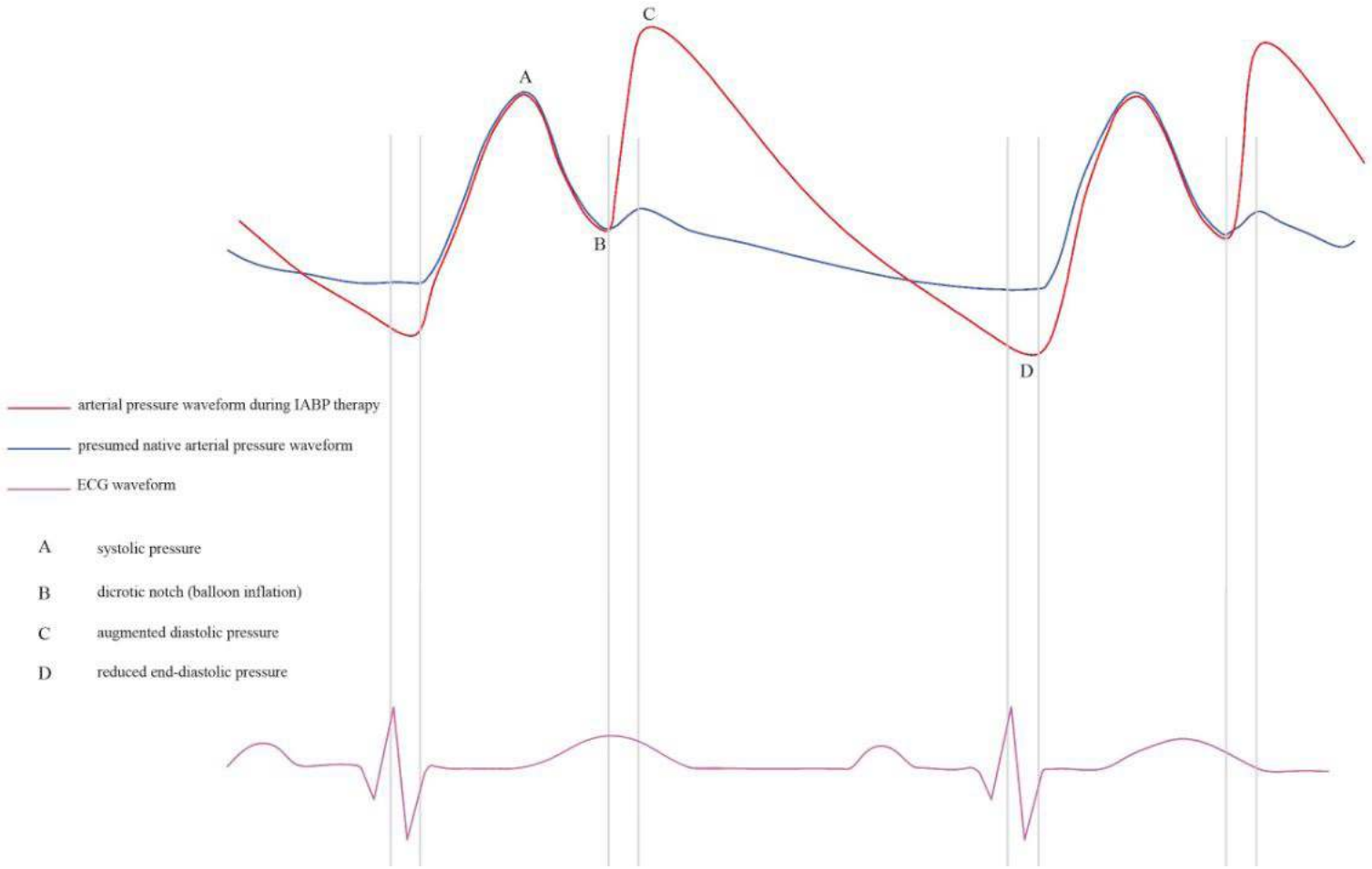


Late deflation

- In **late deflation,** the balloon remains partly or completely inflated at the beginning of the next systole. Note the balloon assisted aortic end-diastolic pressure (*arrow*) is greater than the unassisted pressure.



Late deflation is an extremely dangerous timing error because the LV must eject against the resistance imposed by the inflated balloon.


C
A
B
D
arterial pressure waveform during IABP therapy
presumed native arterial pressure waveform
ECG waveform
A systolic pressure
B dicrotic notch (balloon inflation)
C augmented diastolic pressure
D reduced end-diastolic pressure

Contra-indications

- **Contraindications:**
  - • Severe aortic insufficiency – as the balloon inflates, blood may be forced across the valve thereby overloading the ventricle and increasing cardiac work.
  - • Aortic aneurysm – the increased pressure generated by counterpulsation may cause the aneurysm to rupture.
  - • Severe peripheral vascular disease may limit the ability to advance the catheter through atherosclerotic vessels.
  - • Severe coagulopathy

- **Complications:**
  - • Limb ischaemia due to occlusion of the femoral artery either by the catheter or by emboli from thrombus formation on the balloon
  - • Aortic dissection during insertion or rupture during pumping
  - • Haemorrhage from insertion site
  - • Helium emboli from the balloon
  - • Infection at site of insertion or catheter related

Nursing Care

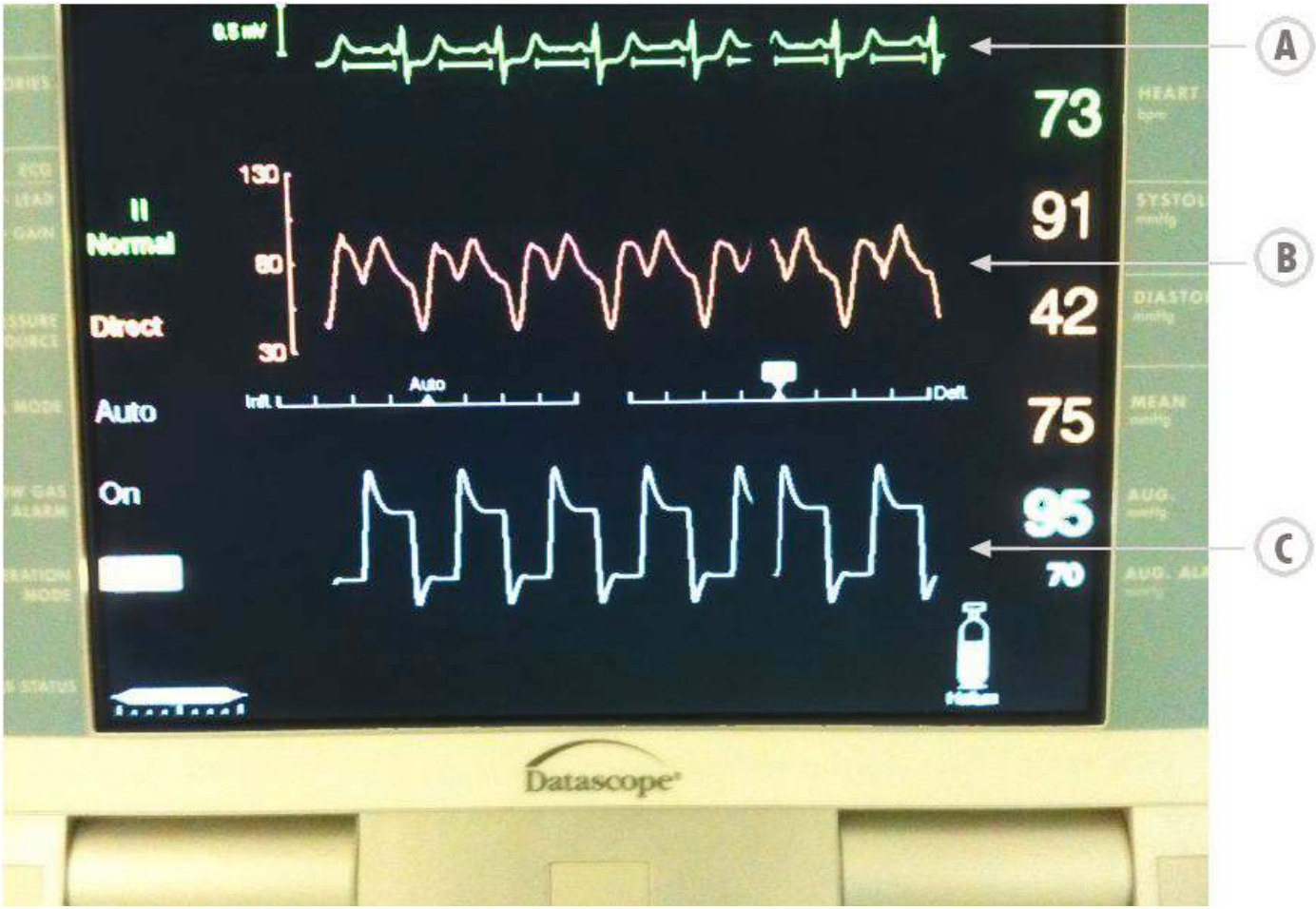
- Transduce the aortic arterial line (balloon lumen) level with the patient's mid-axillary line.

- • For arterial flush bag use normal saline 500mls.
- • Hourly monitoring of:

  - heart rate and rhythm
  - record systolic/diastolic/mean arterial pressures and diastolic augmentation
  - pedal pulses distal to the catheter site (Doppler may be necessary to assess pulse)
  - L) 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 and the end of the bed elevated no more than 30degrees 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 prn
- • Carefully monitor the insertion site for signs of bleeding, infection, haematoma, or compartment syndrome of the affected limb.
- • Heparinisation according to protocol may be initiated at 24 hours.

The Monitor


0.5 mV
73
HEART
bpm
II
Normal
130
60
30
91
SYSTOL
mmHg
Direct
42
DIASTOL
mmHg
Auto
Init
Auto
Def
75
MEAN
mmHg
On
95
AUG.
mmHg
70
AUG. ALA
mmHg
Datascope
A
B
C

Cardiac Arrest

- **Cardiac Arrest:**
  - • Switch to pressure triggering once pump alarms due to loss of ECG rhythm (remember to select "assist" after changing trigger modes). Reduce the pressure threshold if balloon fails to pump from pressure trigger (decrease arrows in auxiliary box under trigger options).
  - • The balloon pump does not need to be disconnected during defibrillation.
  - • If CPR cannot generate a consistent and reliable trigger, then switch to “INTERNAL” mode which will maintain movement of the IAB and therefore reduce the risk of thrombus formation.
  - **WARNING**: The use of “INTERNAL” trigger will produce asynchronous counterpulsation and should never be used in the event that the patient has an ECG or arterial pressure source available. Once the ECG or arterial signal has been reestablished, the trigger mode must be changed from “INTERNAL” to an acceptable patient trigger.