Overview

• Indications
• Contra-indications
• Practical considerations
• IABP waveforms
• Physiology
• Complications
Indications

• With proven benefit
  – Mechanical complications of AMI (acute MR & VSD)
  – Refractory ventricular arrhythmias
  – Refractory unstable angina
  – Decompensated systolic heart failure as a bridge to definitive management

• With possible benefit
  – Cardiogenic shock secondary to AMI refractory to medical therapy\(^1\)
  – Peri-operative support for high risk CABG
  – Peri-operative support for high risk cardiac patients undergoing non-cardiac surgery
  – Decompensated aortic stenosis

• With no evidence to suggest benefit
  – Sepsis
  – Routine use in high-risk patients undergoing PCI\(^2\)
Contra-indications

• Absolute
  – Aortic regurgitation
  – Aortic dissection
  – Chronic end-stage heart disease with no anticipation of recovery
  – Aortic stents

• Relative
  – Uncontrolled sepsis
  – Abdominal aortic aneurysm
  – Tachyarrhythmias
  – Severe peripheral vascular disease
  – Major arterial reconstruction surgery
Practical considerations

- Systemic heparinisation required
- 30-40ml balloon
- Inflated with helium or carbon dioxide
- Dual lumen
  - Inner lumen connected to pressure transducer
  - Outer lumen in continuity with balloon and connected to gas supply
- Electrocardiogram sensor
- Timing
  - Inflates on T wave
  - Deflates on the R wave
- If poor synchronisation occurs in arrhythmias, the arterial waveform can be used as a substitute
Positioning IABP

Metallic tip should be 2cm distal to the left subclavian artery

On chest x-ray, this is just cephalad to the carina
Cardiac cycle

Aortic pressure waveform

Systolic pressure

Diastolic pressure

Dicrotic notch

Electrocardiogram

Time

Q S T P R
IABP waveform

Augmented diastolic pressure

Unassisted systolic pressure  Assisted systolic pressure

Assisted end-diastolic pressure

Unassisted diastolic pressure
1:2 augmentation

1:1 augmentation
Problems with timing
Inflation prior to AV closure

Waveform
- Diastolic augmentation encroaches onto systole

Physiological effects
- Potential premature closure of AV
- Increased LVEDV & LVEDP
- Increased afterload
- Aortic regurgitation
- Increased myocardial $O_2$ demand
Inflation after AV closure

Waveform
• Absence of sharp V
• Sub-optimal diastolic augmentation

Physiological effects
• Sub-optimal coronary artery perfusion
Premature deflation during diastole

**Waveform**
- Sharp drop following diastolic augmentation
- Sub-optimal diastolic augmentation
- Assisted end diastolic pressure equal or greater than un-assisted EDP
- Assisted systolic pressure may rise

**Physiological effects**
- Sub-optimal coronary perfusion
- Retrograde coronary/carotid blood flow
- Sub-optimal afterload reduction
- Increased myocardial $\text{O}_2$ demand
Late deflation in diastole as AV beginning to open

**Waveform**
- Assisted EDP equal to un-assisted EDP
- Prolonged rate of rise of assisted systole
- Widened diastolic augmentation

**Physiological effects**
- Absent afterload reduction
- Increased myocardial O2 demand as LV ejecting against greater resistance
Physiology

• Aorta
  – Reduces systolic pressure
  – Increases diastolic pressure

• Left ventricle
  – Reduces systolic pressure
  – Reduces end-diastolic pressure

• Overall
  – Reduces afterload
  – Reduces preload
  – Increases cardiac output
  – Increases coronary blood flow
Physiology

• Diastolic Pressure Time Index (DPTI)
  – Area between LV pressure and aortic pressure waveform in diastole
  – Represents pressure and time available for coronary blood flow

• Tension Time Index (TTI)
  – Area under the LV pressure waveform in systole
  – Represents myocardial work and O₂ demand

• Endocardial Viability Ratio
  – Ratio of the DPTI to the TTI
  – Thought to represent the ratio of myocardial O₂ supply to demand
  – Myocardial ischaemia likely when ratio <0.7
Physiology

- Balloon inflation increases pressure difference between aorta and LV which augments the DPTI
- This increases $O_2$ supply

- Balloon deflation reduces the afterload of the LV which reduces the TTI
- This reduces $O_2$ demand
Complications

• Incidence
  – Major (2.8%)
  – Minor (4.2%)

• Vascular
  – Aortic dissection
  – Peripheral thrombotic embolisation
  – False aneurysm or AV fistula formation

• Balloon related
  – Balloon migration leading to
    • Renal ischaemia
    • Visceral ischaemia
    • Spinal cord ischaemia
    • Limb ischaemia
  – Balloon rupture leading to gas embolisation
  – Thrombocytopenia
  – Anaemia

• Infection
Practice SAQ 1

• List the indications and contra-indications for inserting an intra-aortic balloon pump. (35%)
• Describe the mechanism of action and physiological effects of an IABP. (30%)
• What are the potential complications of IABP insertion? (35%)
Practice MCQ 1

1. Physiological effects of intra-aortic balloon pump include:
   • Increase in systolic blood pressure
   • Increase in diastolic blood pressure
   • Increase in cardiac output
   • Decrease in left ventricular end-diastolic pressure
   • Increase in coronary blood flow
2. Contra-indications to insertion of IABP include:

• Coagulopathy
• Severe mitral regurgitation
• Severe aortic regurgitation
• Chronic end-stage heart disease
• Cardiomyopathy
3. Regarding intra-aortic balloon pump:

• Helium is used owing to its high density and low solubility in blood
• Optimum time for inflation is just before the closure of the aortic valve
• The balloon should never be turned off in situ
• The balloon can be programmed to be time-cycled
• Augmented diastolic pressure is ideally higher than the patient’s systolic pressure
4. Regarding weaning from IABP:

- Weaning should be considered regardless of patient’s inotropic dependence
- The balloon should be turned off and the patient’s haemodynamic status observed
- Removal of the balloon pump may result in an increase in inotropic requirements
- Weaning can be achieved by reducing balloon volume
- Weaning can be achieved by reduced the ratio of augmented to native beats
5. Complications associated with IABP include:

- Compartment syndrome
- Aortic dissection
- Arrhythmias
- Thrombocytopenia
- Cardiac tamponade
MCQ answers

• 1. FTTTT
• 2. TFTTF
• 3. FFTFT
• 4. FFTTT
• 5. TTFTT
References

Review articles


References

Evidence base