AWSOME

Anaesthesia Written ShOrt answer & Multiple choice Examination Course

Intra-aortic balloon pumps

David Connor

Overview

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

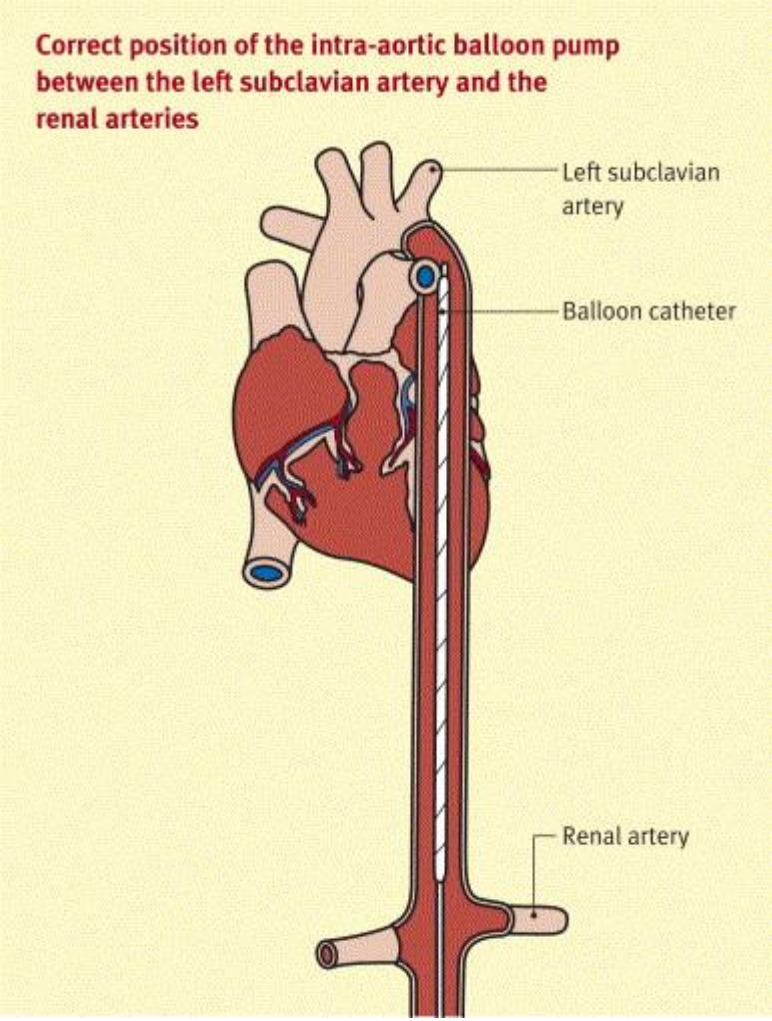
Indications

- 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

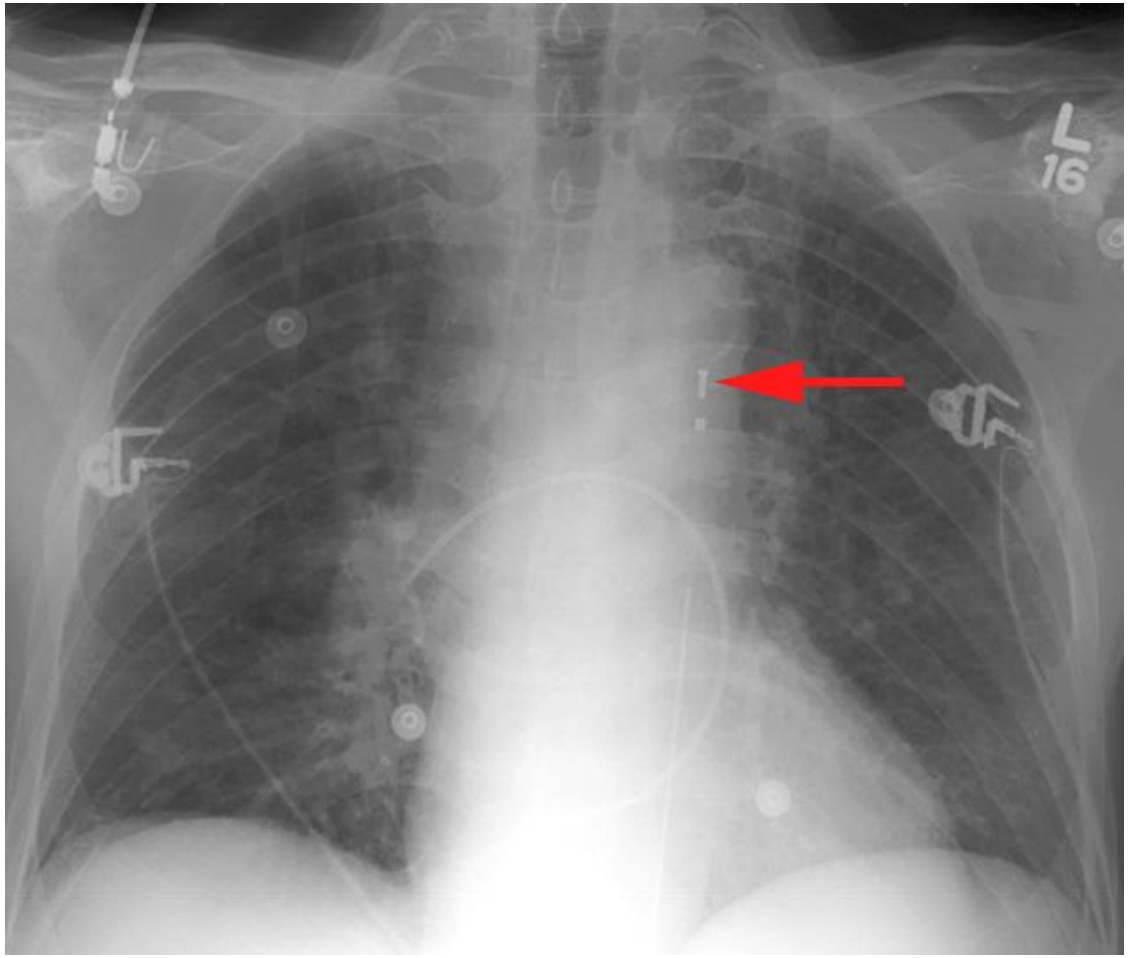
- Absolute
  - Aortic regurgitation
  - Aortic dissection
  - Chronic end-stage heart disease with no anticipation of recovery
  - Aortic stents
- Relative
  - Uncontrolled sepsis
  - Abdominal aortic aneurysm
  - Tachyarrhythmias
  - Severe peripheral vascular disease
  - Major arterial reconstruction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

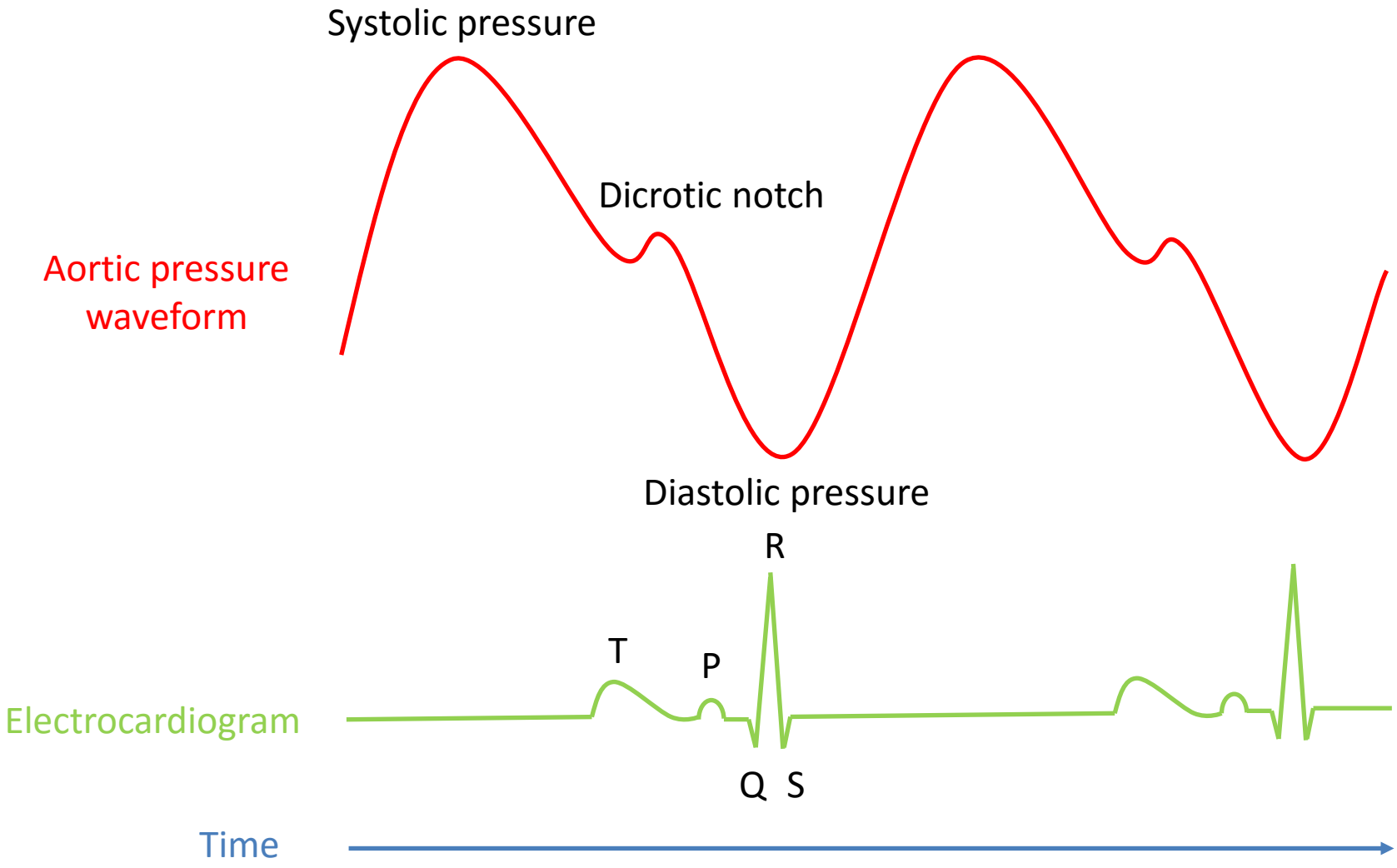
Positioning IABP



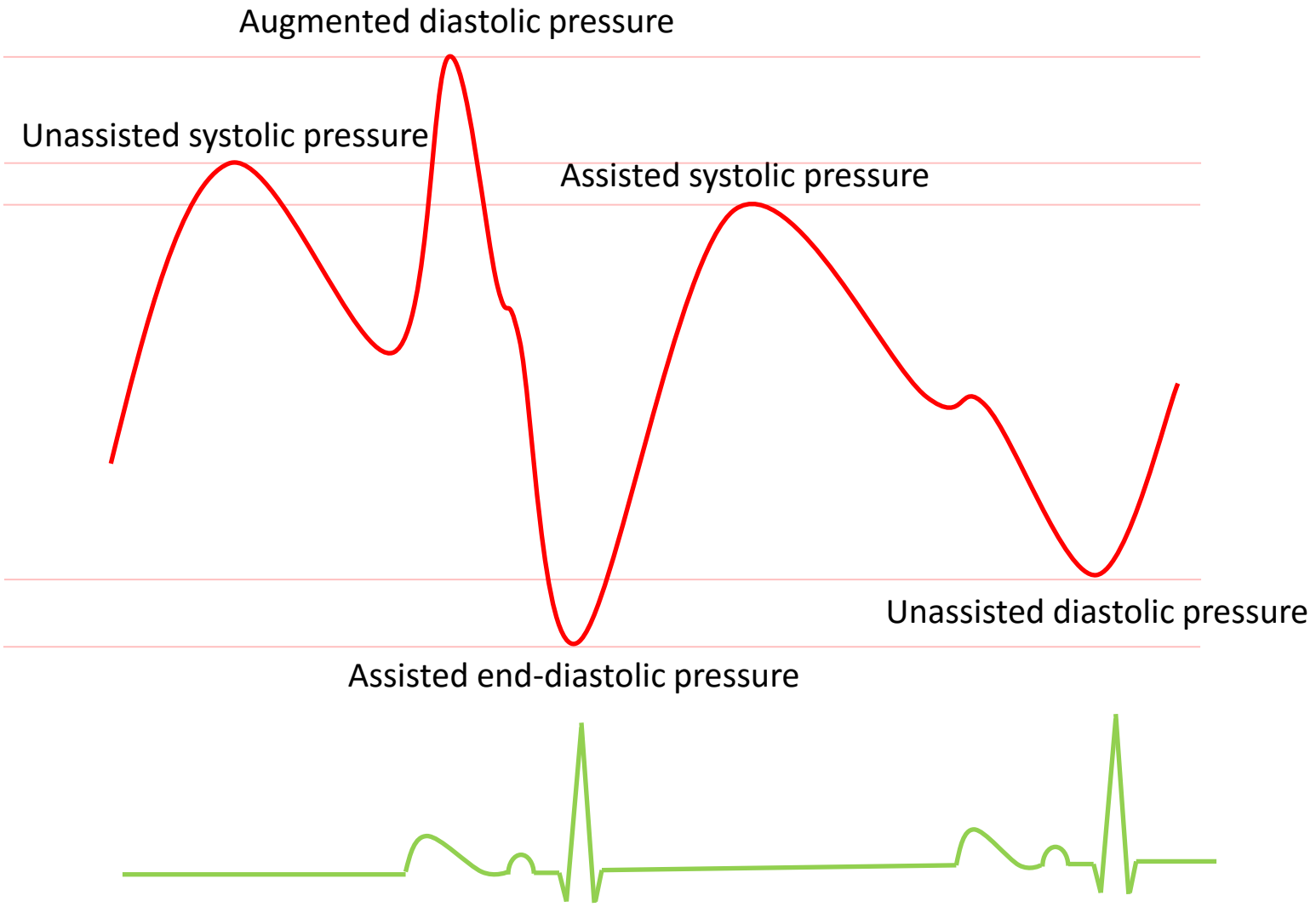
Metallic tip should be 2cm distal to the left subclavian artery

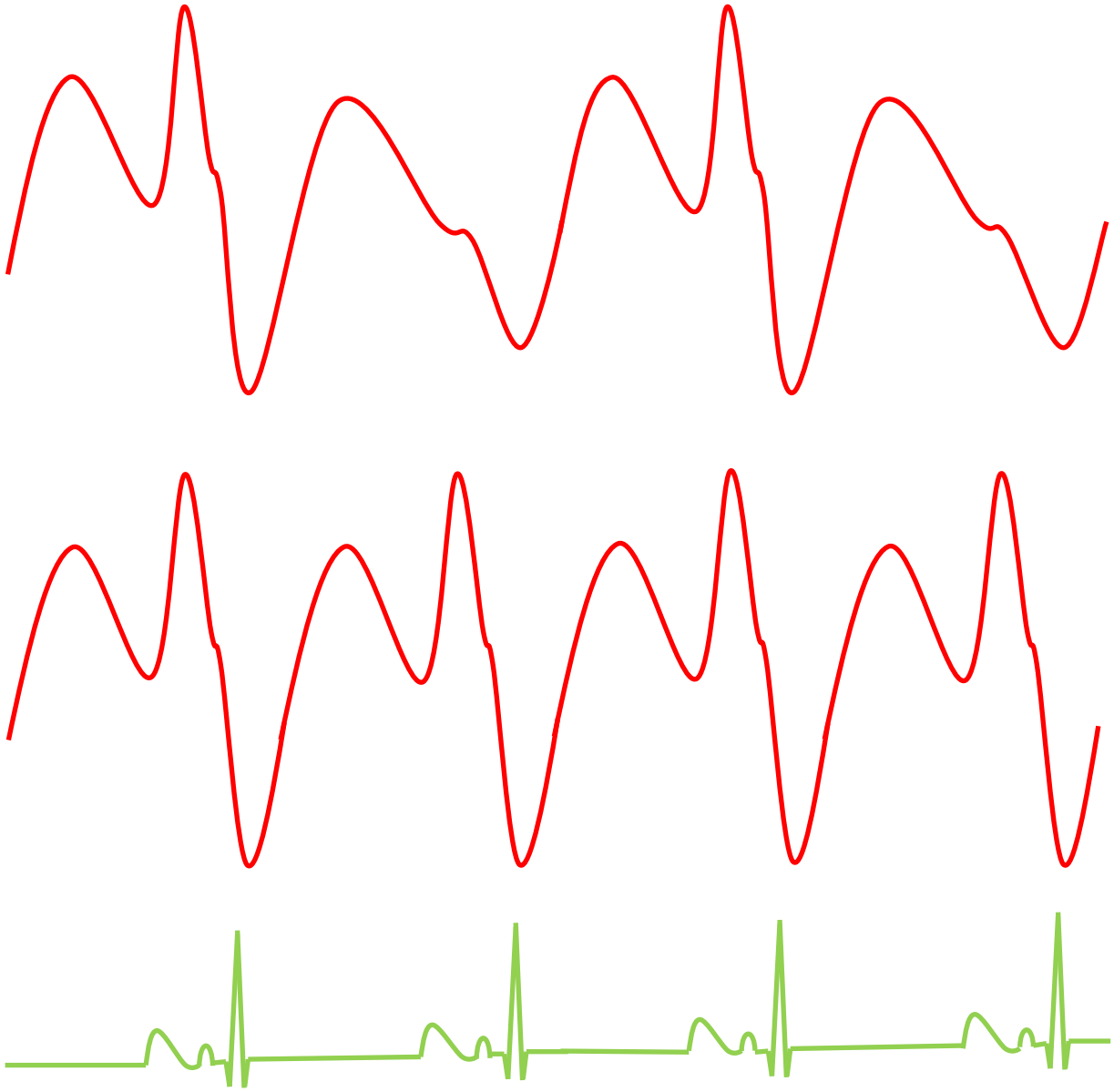
On chest x-ray, this is just cephalad to the carina

Cardiac cycle



IABP waveform



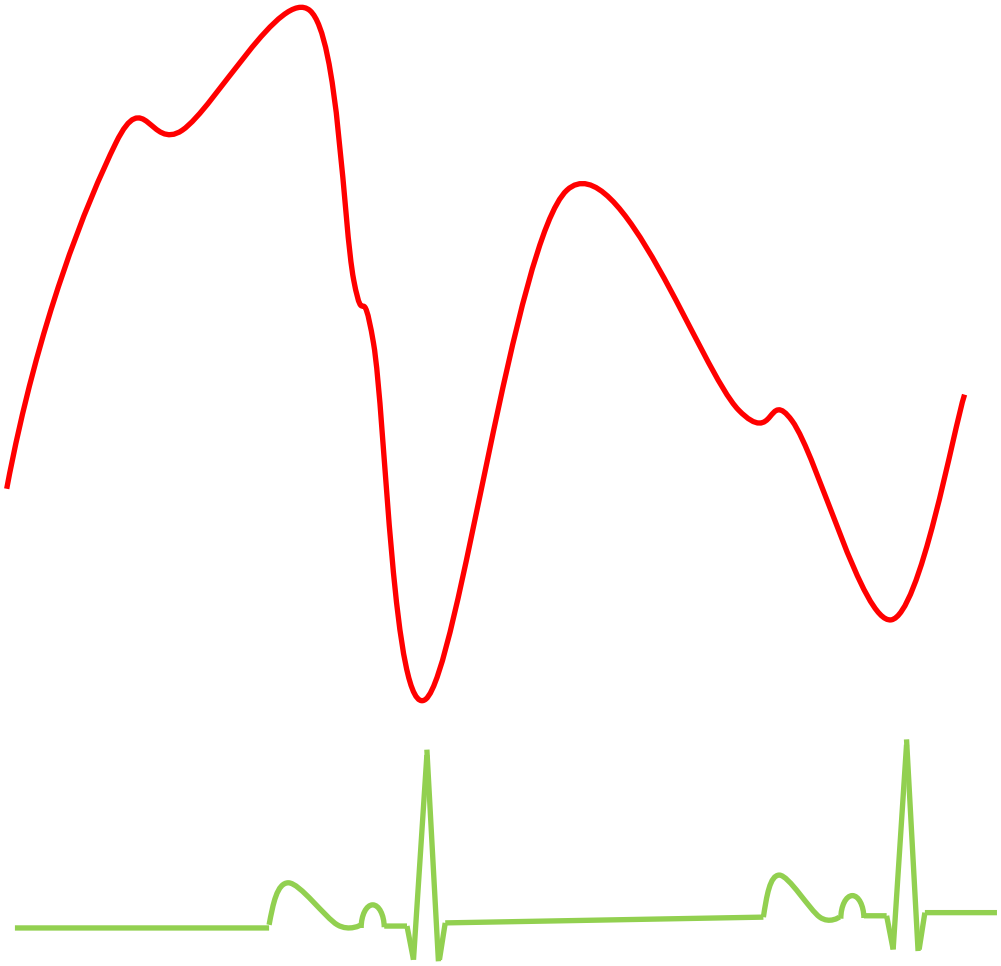


1:2 augmentation

1:1 augmentation

Problems with timing

Inflation prior to AV closure



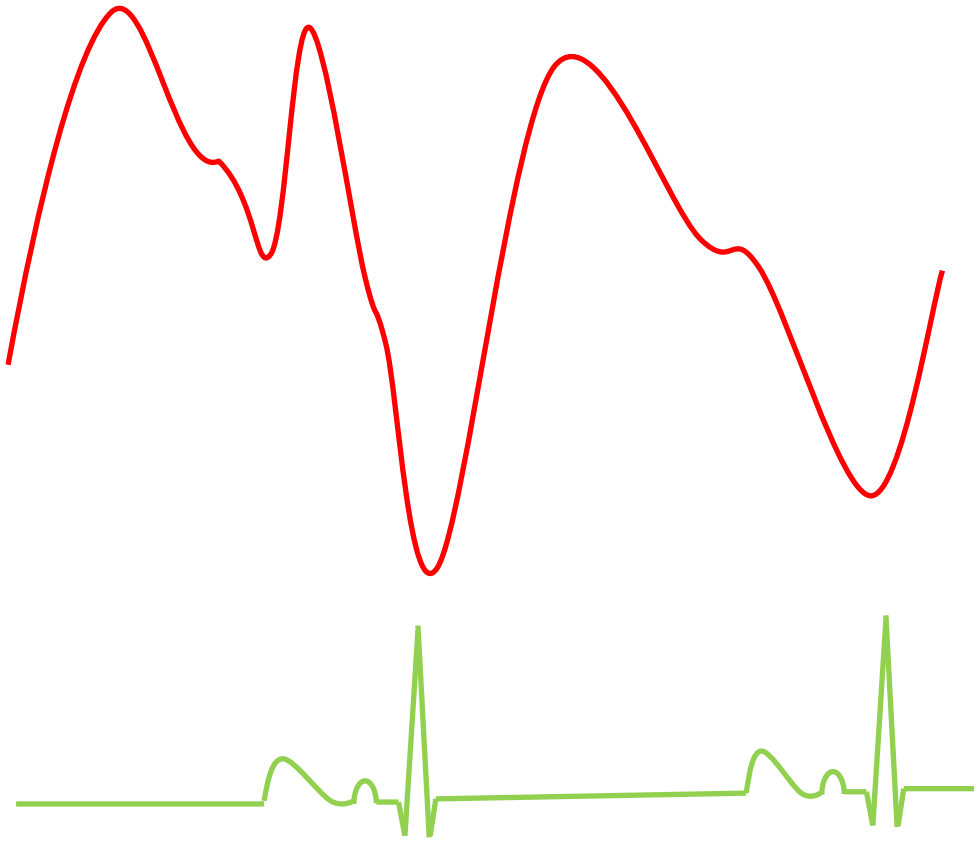
Waveform

- 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



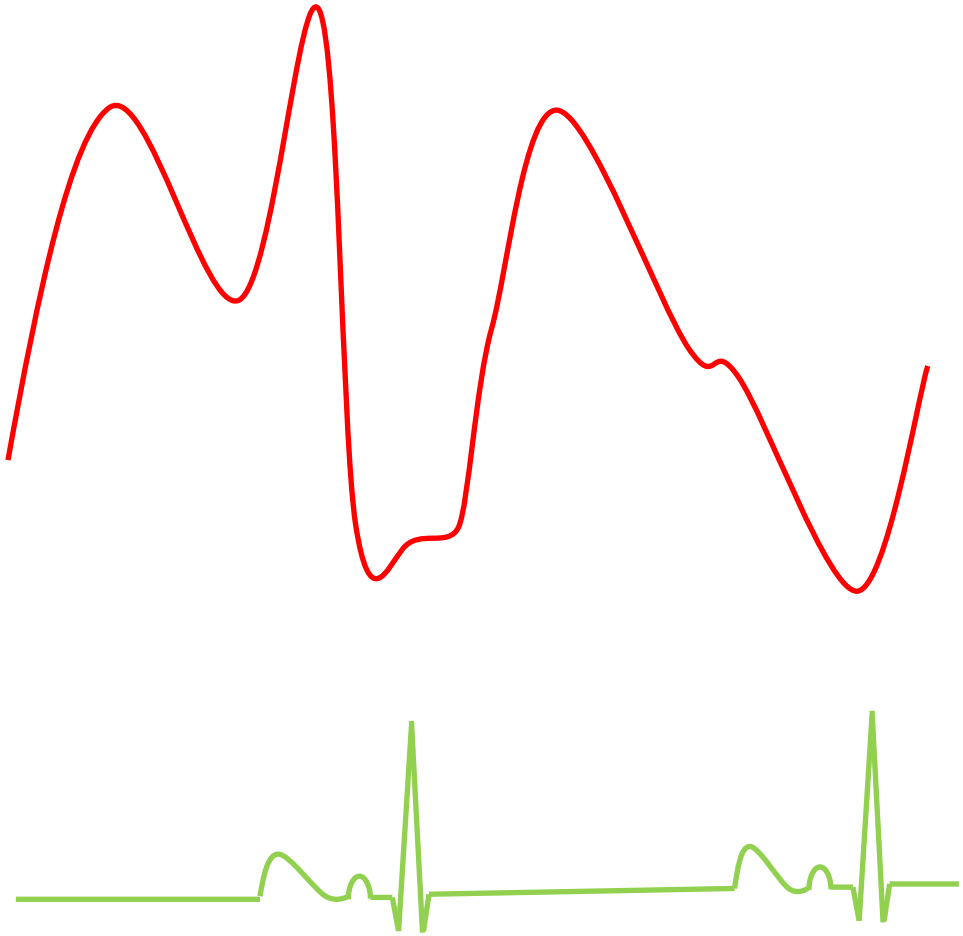
Waveform

- Absence of sharp V
- Sub-optimal diastolic augmentation

Physiological effects

- Sub-optimal coronary artery perfusion

Premature deflation during diastole



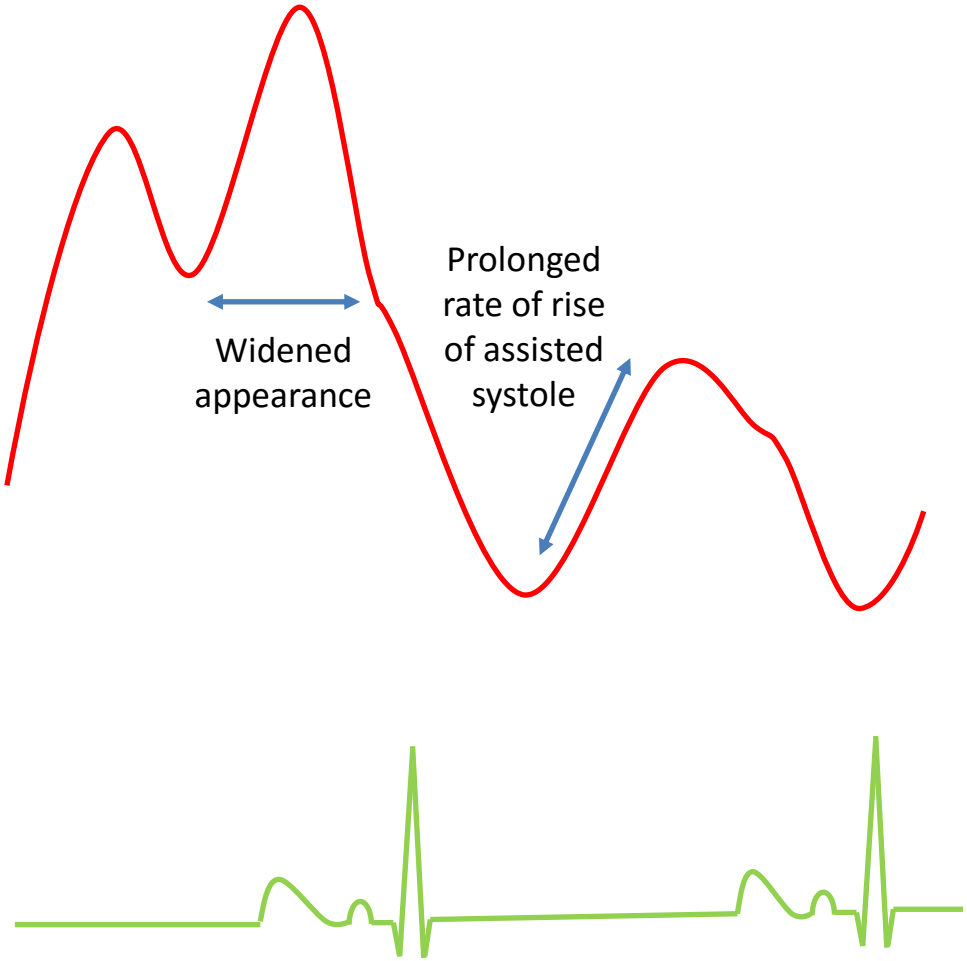
Waveform

- 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 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

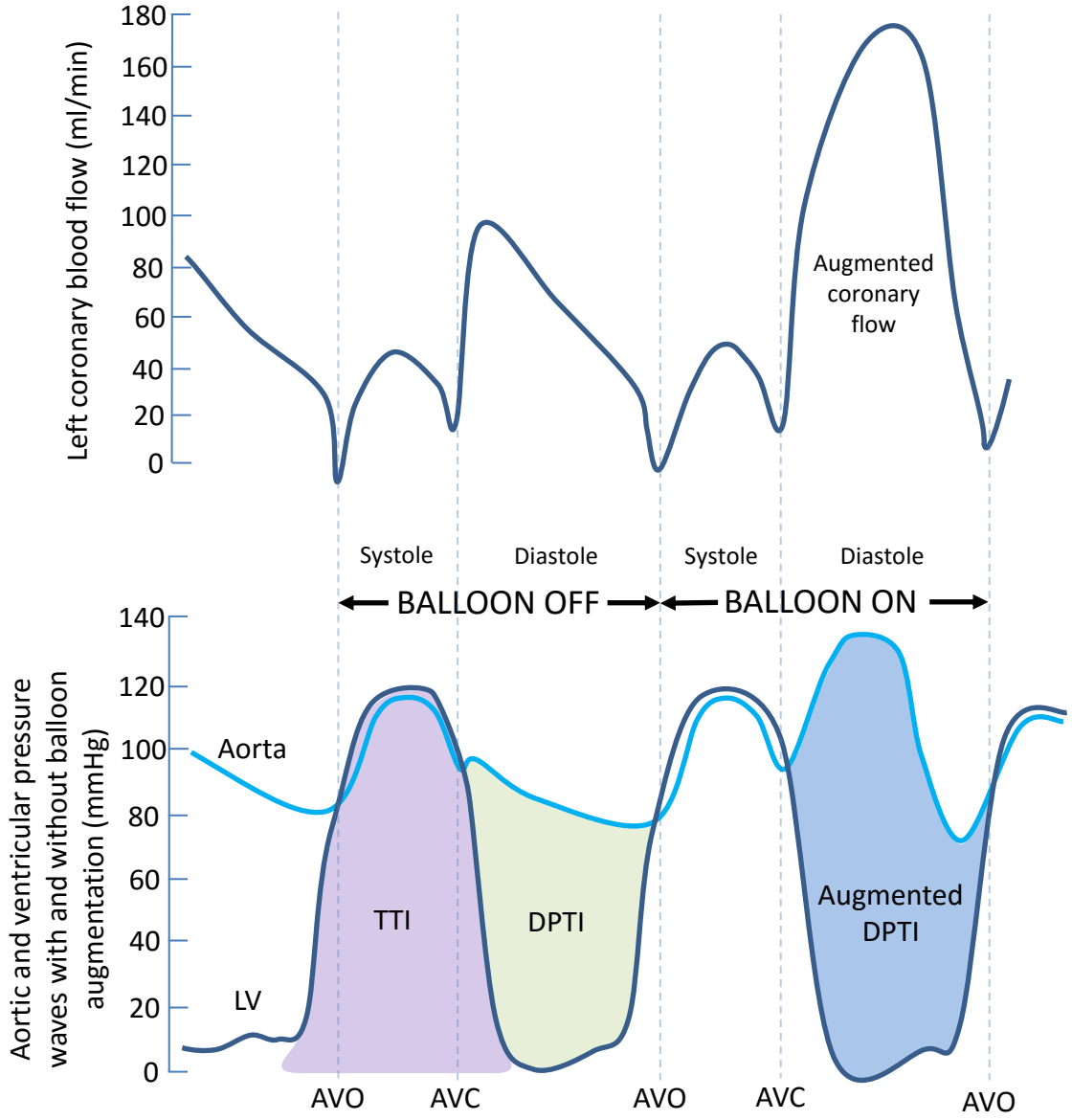
Physiology

- 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 O_2 demand
- Endocardial Viability Ratio
  - Ratio of the DPTI to the TTI
  - Thought to represent the ratio of myocardial O_2 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
  - Thrombocytopaenia
  - 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

Practice MCQ 2

2. Contra-indications to insertion of IABP include:

- Coagulopathy
- Severe mitral regurgitation
- Severe aortic regurgitation
- Chronic end-stage heart disease
- Cardiomyopathy

Practice MCQ 3

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

Practice MCQ 4

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

Practice MCQ 5

5. Complications associated with IABP include:

- Compartment syndrome
- Aortic dissection
- Arrhythmias
- Thrombocytopaenia
- Cardiac tamponade

MCQ answers

- 1. FTTTT
- 2. TFTTF
- 3. FFTFT
- 4. FFTTT
- 5. TTFTT

References

Review articles

- Alaour B & English W, (2011) Intra-aortic balloon counterpulsation, *Anaesthesia Tutorial of the Week 220*, http://www.frca.co.uk/Documents/220%20Intra-aortic%20Balloon%20Pump%20Counterpulsation.pdf

- Krishna M & Zacharowski K, (2009) Principles of intra-aortic balloon pump counterpulsation, *CEACCP*, 9(1): 24-28.

References

Evidence base

1. Sjauw K et al, (2009) A systematic review and meta-analysis of intra-aortic balloon pump therapy in ST-elevation myocardial infarction: Should we change the guidelines?, *European Heart Journal*, 30: 459-468.

2. Perera D et al, (2010) Elective intra-aortic balloon counterpulsation during high risk percutaneous coronary intervention: A randomised control trial, *JAMA*, 304(8): 867-874.