ROLE OF INTRA AORTIC BALLON PUMP IN CPB

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ABSTRACT

The protection of the heart throughout the procedure is one of the main issues with cardiac surgery. Due to their poor energy stores, diseased hearts are particularly vulnerable to further ischemia harm. In patients with persistent cardiac failure following cardiopulmonary bypass, in the peri-infarct period, or while treating complications of coronary artery angioplasty, intra-aortic balloon pump therapy is frequently life-saving. The majority of IABP patients are under the direct care of an anaesthesiologist, who must have a complete awareness of the apparatus, its physiological effects, and any potential issues. The current CPB circuit enables complete circulatory support, regulation of gas exchange, and temperature management through the use of a network of tubing, pumps, oxygenators, heat exchangers, and numerous safety and electrical components. The principles of cardiopulmonary bypass, related physiological abnormalities, and the use of intra-aortic balloon pumps in cardiac surgery patients are covered in this chapter.

Keywords: Cardiopulmonary bypass, Intra-aortic balloon pump, Bypass circuit, Perfusion.

I. INTRODUCTION

In 1968, the intra-aortic balloon pump (IABP) was first made available. It decreases the afterload and myocardial effort and enhances diastolic coronary and systemic blood flow. After ST-segment elevation myocardial infarction (STEMI), several physiologic responses are thought to aid myocardial and organ healing. Animal studies show that IABP treatment improves myocardial salvaging. IABP is also recommended as a stabilizing agent or as a way to avoid catheterization laboratory mishaps. IABP has been in operation for approximately 40 years and is now considered an advanced technology. It is currently the most used type of mechanical cardiac support in acute cardiology.

II. Intra-Aortic Balloon Pump

This device reduces aortic end diastolic pressure (Afterload) by abruptly dropping aortic pressure after balloon deflation. This lessens the strain exerted on the left ventricle. It enhances myocardial oxygen supply by mechanically rerouting cardiac blood flow to the vital organs (Coronary & carotid circulation) during balloon inflation. The intra-aortic balloon catheter, which is placed into the aorta, and a machine outside the body are the two primary components of the intra-aortic balloon pump. The balloon's helium-controlled inflation and deflation are managed by a console that is fastened to it. Since helium dissolves readily in blood, using it reduces the risk of air emboli if the catheter ruptures [1].

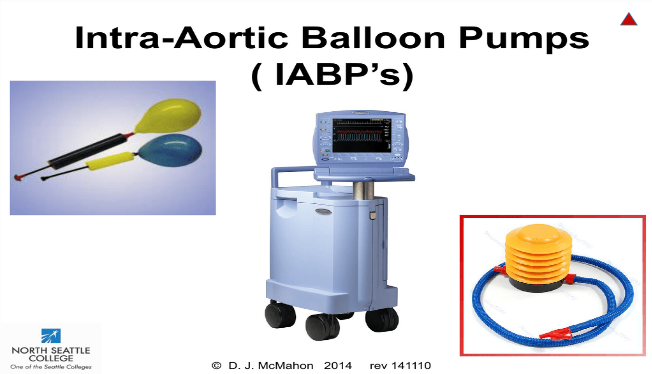

Figure 1: Intra-aortic balloon pump

III. PRIMARY EFFECTS OF IABP

Increase myocardial oxygen supply: Increasing diastolic pressure will result in increased coronary perfusion, which can increase the amount of oxygen delivered to the heart tissue.

Reduce the need for myocardial oxygen: Systolic pressure reduction through end diastolic pressure reduction will lessen the left ventricle's workload, requiring the heart to work less hard to pump blood through the aorta. Unexpected deflation creates a space in the aorta that aids in shifting the left ventricle's volume, thereby reducing the afterload. This will completely empty the left ventricle's volume, improving cardiac output and lowering the wall tension inside the ventricle, which lowers the load on the heart and reduces the need for oxygen [2].

IV. SECONDARY EFFECTS OF IABP

1. Decreased down heart rate.
2. A rise in heart output.
3. Reducing vascular systemic resistance.
4. Lowering the end diastolic pressure in the left ventricle.
5. Raising the mean arterial pressure will increase the flow of blood to all the organs.
6. Decreases regurgitation of the mitral valve.
7. LV ejection is elevated.

V. IMPACTS ON FURTHER SYSTEMS

Renal: increasing urine output and renal perfusion
Neuro: enhancing cerebral perfusion and mental state
Respiratory: enhancing respiratory performance by reducing pulmonary capillary wedge pressure and pulmonary diastolic pressure in an artery
Vascular: reducing vascular resistance throughout the body and enhancing peripheral perfusion.

VI. INDICATIONS

Cardiogenic shock, pre-shock syndrome, and myocardial infarction that is at risk of spreading Intractable ventricular arrhythmias, unstable angina Cardiac contusion, the septic shock syndrome, Support for high-risk interventional therapies such as stents, thrombolysis, coronary angioplasty, and other operations that are preventative in nature.

COMPLICATIONS:

- Aortic wall:
  - Dissection
  - Rupture
  - Local vascular injury
- Emboli:
  - Thrombus
  - Plague
- IAB rupture:
  - Helium embolus
  - Catheter entrapment
- Infection:
- Obstruction:
  - Malposition
  - Compromised circulation due to catheter causing ischaemia or compartment syndrome [3].

VII. BALLOON STRUCTURE AND POSITION

A thin polyurethane balloon attached on a catheter makes up the intra-aortic balloon catheter. Either surgically or percutaneously, the balloon catheter is introduced into the patient's aorta by passing it up through the femoral artery and into the descending aorta. The descending thoracic aorta, directly distal to the left subclavian artery, is the best location for the balloon. The balloon is perfectly positioned so that the intersection of the descending aorta and the aortic arch is where its tip should be. This reduces the chance that the balloon will occlude the renal artery and encourages the evacuation of blood from the proximal aorta. The balloon catheter is then attached to a console that inflates and deflates the balloon by transferring helium in and out of the balloon [4].

The balloon helps the heart in two different ways:

1. To improve coronary perfusion, it raises aortic pressure during diastole.

2. To reduce the strain on the heart, it lowers aortic pressure during systole. ventricular left.

The balloon's inflation and deflation are used to achieve this. The helium will systole and diastole, respectively, and be inflated. Inflating the intra-aortic balloon has the following main effects: myocardial oxygen demand while increasing oxygen supply.

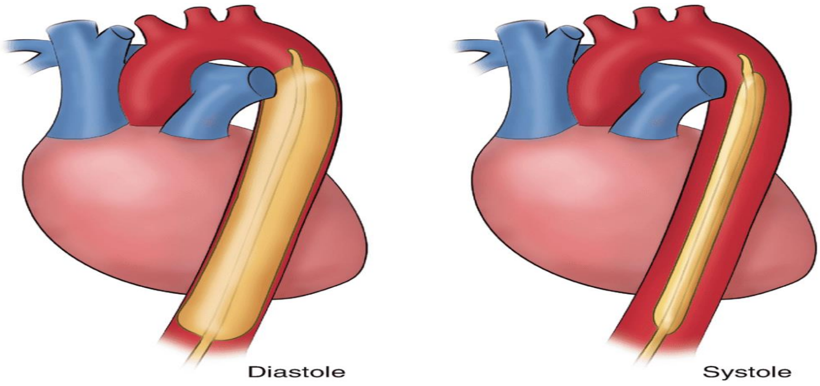

Figure 2: Balloon inflation and deflation

VIII. ASSESSMENT OF TIMING

To provide the patient the full advantage, the balloon pump needs to be timed precisely. The diastole phase is used to fill the balloon. Diastole begins when the aortic valve closes and the left ventricle relaxes. The heart is not pumping blood forward during this period of the cardiac cycle. The balloon's inflation at this moment won't prevent blood from flowing forward. The dicrotic notch on the arterial pressure tracing indicates that the aortic valve is closed. The balloon's inflation is timed to happen at the arterial pressure trace's dicrotic notch. Diastolic pressure is increased as the balloon expands, improving coronary artery blood flow and myocardial oxygenation. Aortic valve opening requires deflation of the balloon [5].

IX. TIMING PRINCIPLES FOR INFLATION AND DEFLATION

During the diastolic phase of the cardiac cycle, the IABP is planned to enlarge after the aortic valve closes. When using a central aortic root arterial line, inflation should precisely occur at the location of the dicrotic notch. To account for delayed waveform transmission when using a peripheral artery line, time must be significantly modified. The pressure inside the proximal descending and ascending aorta suddenly rises during inflation. Additionally, as the balloon is inflated, the distal blood flow is increased [6]. This typical physiological occurrence takes place when the blood bolus discharged from the left ventricle enters the aorta and causes aortic wall distension. The elastic walls of the aorta rebound, compressing the volume of the aortic blood before the subsequent systolic ejection. This promotes blood flow, resulting in constant diastolic blood flow. The aorta wall stretches and distends more as a result of IAB inflation, improving forward blood flow and producing a more elastic rebound as the balloon deflates.

Increased diastolic perfusion pressure and improved circulation with an omnidirectional pattern are the end results of IAB inflation, which are advantageous for both coronary artery and systemic perfusion.

To avoid impeding blood flow from the left ventricle and lessen afterload, the IABP is scheduled to deflate right before and throughout the systolic phase of the cardiac cycle. The IAB deflates just prior to systolic ejection from the left ventricle. A vacuum-like effect is produced by the sudden drop in aortic pressure, which reduces systemic vascular resistance (SVR) and enhances blood flow. The afterload or isovolumetric contractile force of the left ventricle is also decreased as a result of this impact. IABP-assisted peak systolic pressure and myocardial oxygen consumption are thus reduced. Both the impacts of inflation and deflation boost cardiac output. Myocardial performance is improved by increased coronary artery perfusion, while afterload reduction reduces performance [7].

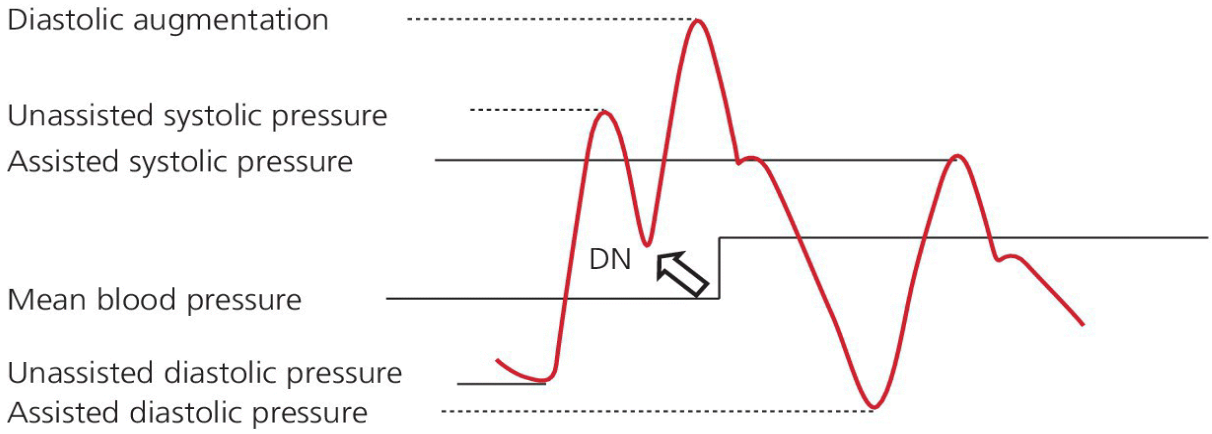

Figure 3: Dicrotic notch

X. CONCLUSION

Intra-aortic balloon pump therapy is commonly life-saving in patients with chronic heart failure during cardiopulmonary bypass, in the peri-infarct phase, or while addressing complications of coronary artery angioplasty. The majority of IABP patients are under the direct supervision of an anaesthesiologist, who must have a complete awareness of the apparatus, its physiological effects, and any potential consequences, directly asses cardiac output.

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