Background text technical press

Cardiogenic shock: Impella® heart pumps improve hemodynamics

50% of the patients suffering from cardiogenic shock die due to circulatory or multi-organ failure. Mechanical circulatory support systems such as Impella heart pumps may improve hemodynamics and facilitate the recovery of the heart muscle [1].

Cardiogenic shock - caused by failure of the pump action of the heart - creates a vicious circle resulting in reduced cardiac output, low blood pressure, poor coronary perfusion and further decreased heart contractility. If untreated, cardiogenic shock leads to multi-organ failure and the patient’s death. In approximately 80% of the cases, cardiogenic shock is caused by left ventricular dysfunction after myocardial infarction. Damaged heart valves or an inflammation of the heart muscle are less frequent triggers. About 5% to 10% of the patients with myocardial infarctions suffer a cardiogenic shock within the first few days, with 50% of the deaths occurring in hospital [2].

The current standard of care includes early revascularisation and the treatment with inotropic agents (inotropes) or catecholamines. However, these medications are only effective if enough functioning heart tissue remains. Alternatively, percutaneous mechanical circulatory support systems, such as Impella heart pumps, may offer a way out of this life-threatening situation.

What are the effects of Impella heart pumps?

The Impella systems are suitable for supporting the left or the right ventricle. The Impella 2.5® and the Impella CP® heart pumps are retrogradely positioned in the left ventricle, across the aortic valve. The specially designed pump impeller continuously pumps the blood from the left ventricle into the ascending aorta at a rotation speed of up to 50,000 rotations per minute. This happens independent of the heartbeat. Blood is being pumped into the aorta even during the resting period between the contractions of the ventricles.

The Impella 2.5 heart pump allows for a maximum flow of 2.5 l/min, whilst the Impella CP heart pump can pump 3.5 l/min. The Impella 5.0® heart pump transports up to 5 l/min. Its placement requires a vascular intervention. The pumps are operated via a transportable console that can also run independently of AC power for up to 60 minutes.

The Impella RP® heart pump is indicated to provide right ventricular support. The pump can be inserted via the femoral vein and connects the inferior vena cava via the tricuspid and pulmonary
valve with the pulmonary artery. It is able to pump approximately 4 litres of venous blood into the lung artery.

The use of the left-ventricular Impella heart pump increases the ejection fraction whilst simultaneously reducing cardiac work. Impella heart pumps increase the systemic aortic and mean arterial pressure. The left ventricle is unloaded, cardiac output and coronary perfusion improve. The myocardial oxygen supply and demand are much better balanced. The changes induced by the Impella systems optimise the requirements for a recovery of the heart. [3, 7].

When is it appropriate to use the Impella heart pump?

Key factors for successful therapy are a rapid detection of patients with cardiogenic shock and a timely intervention. If a hospital is not able to provide immediate cardiac catheterization, cardiac and organ parameters may be used for diagnosis. Signs of inadequate blood flow to the organs are manifested by a systolic blood pressure of below 90 mmHg >30 min. Further symptoms include an altered sensorium, cold extremities, reduced diuresis and an elevated plasma lactate level above 2 mmol/l. The plasma lactate level is an excellent surrogate parameter for estimating tissue oxygenation and helps to identify inadequate blood flow to organs in shock.

Evidence of survival benefits

The prospective ISAR-SHOCK study published in 2008 showed for the first time that the Impella 2.5 heart pump promotes better hemodynamic support in patients with cardiogenic shock than the standard therapy with an intra-aortic balloon pump (IABP) [4].

Another study retrospectively analysed the data of 47 patients with an Impella heart pump. 32 patients had suffered from post-cardiotomy cardiogenic shock, 11 following myocardial infarction, 3 following acute decompensated ischemic cardiomyopathy and 1 due to myocarditis. The ventricular function improved in 72 % of the patients. The 30-day mortality in this high-risk group was 25% and thus significantly lower than the commonly observed mortality rate of 50% [5].

The cVAD (formerly USPella) Registry compared data of 154 patients who had received an Impella 2.5 heart pump either before or after PCI. Patients with refractory cardiogenic shock had a better survival rate if they were supplied with the Impella pump before PCI. [6]. Early detection of cardiogenic shock - and thus early left ventricular unloading before PCI - is associated with an improved chance of survival [6].

Best Practice data

Data from 791 Impella user centers show greatly varying survival rates of patients suffering from cardiogenic shock after myocardial infarction, and a potential for improvement of the results by standardizing the Impella application. This was assessed during the course of a “National Cardiogenic Shock Initiative” by Dr. William O’Neill from Detroit. The group subsequently established a common treatment protocol and collected the data to track the results and measure
the success of their program. The first pilot study showed an improvement of the survival rates from 50% to 80% [8].

References


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