

Anaesthesia for implantation of assist devices

J.-U. Lüth

Institut für Anästhesiologie, Herz- und Diabeteszentrum NRW

Applied Cardiopulmonary Pathophysiology 13: 143-145, 2009

Patients needing this hemodynamic support are severely limited in their cardiac function and often have other organ failures. The diminished renal and hepatic functions create additional challenges to the anaesthesiologist. Maintaining an adequate cardiac output and hemodynamic stability during the anaesthesia requires the knowledge of the systems and their pitfalls. The presentation tries to give an overview of the procedure and highlights some problems.

Indications

The indications for the use of assist devices are

- *Post cardiopulmonary bypass*: Patients with ventricular failure after cardiac surgery and maximum inotropic support in combination with IABP support.
- *Ventricular failure*: Patients with myocarditis, post myocardial infarction, dilatative cardiomyopathy and other diseases leading to cardiac failure

The support can be used as a *bridge to recovery*, mostly with patients post cardiectomy, as *bridge to transplantation* and as *destination therapy* with permanent use.

Systems

Three types of cardiac assist systems exist.

The *Centrifugal pumps* are used as a temporary support for a limited time. The cannulas are either placed in the femoral artery and vein or using the cardiopulmonary bypass equipment with the cannulas in the right atrium and aorta for the total support.

Left ventricular assist devices (LVAD) are implanted with a cannula in the left ventricular apex and the outflow into the ascending aorta.

The right *ventricular support* (RVAD) uses an inflow cannula from the right atrium and an outflow to the A. pulmonalis.

Left ventricular systems are either implantable with just an electric cord to the controller or as extracorporeal device with a chamber below the chest.

The Total Artificial Heart (TAH) is a complex system implanted to the right and left atrium with 4 valves and two chambers.

Anaesthesia and monitoring

Usually we use a balanced anaesthesia with fentanyl or sufentanil and sevoflurane. But this is not mandatory. It is important to keep the hemodynamic within the lower normal range and the anaesthesiologist should be familiar with his drug selection.

Some of the patients are intubated, on IABP support or even supported by Centrifugal pump via the femoral artery and vein when they are transported into the OR. The monitoring standard consists of an arterial line, central venous catheter, urine catheter and at least one large bore cannula (often Sheldon catheter) for volume substitution.

Pulmonary catheterisation is mandatory for the LVAD Implantation, but is contraindicated for the TAH. In the case of the extracorporeal BVAD like Thoratec™ the pulmonary catheter is optional.

TEE is a very useful monitoring and should be used for the exclusion of an atrial shunt before the operation. When weaning from the cardiopulmonary bypass the TEE gives valuable information about the position of inflow cannula, ventricular function and filling status.

Other medical problems

The impaired organ functions, due to the heart failure should be considered for the anaesthesia and should be treated accordingly. Quite often patients are hemofiltrated during the procedure. The treatment of coagulation imbalances, either induced by medical treatment prior to implantation or due to reduced hepatic function should be anticipated.

Patent foramen ovale could lead to severe right to left shunting when the left atrial pressure is reduced due to a “better” functioning of the left ventricle when the LVAD is sucking the blood from the ventricle. Therefore a patent foramen ovale should be closed during the operation.

Air sucking of the LVAD: The LVAD's are able to suck in air, as long as the chest is open. To prevent air sucking is it necessary to keep the volume of left ventricle in the upper range as long the chest is open. This could be checked optimal with the TEE or with a left atrial catheter.

Trapping off catheters: The TAH has the right ventricle directly sutured to the right atrium with an artificial valve. This valve could be damaged with a central venous catheter. The central venous catheter must be outside the right atrium!

Pulmonary hypertension

Either acute or chronic pulmonary hypertension may contribute to poor right ventricular (RV) function. To support the compromised right ventricle we usually use milrinone as first line “inodilator”. The use of iloprost inhalation before starting the bypass and immediately afterwards could help to manage the right ventricle, about half of our patients receive iloprost inhalation.

Own experience

- *Blood use:* The mean use of blood is between 6 to 12 units. Lower for LVAD and higher for Redo's and BVAD's and TAH.
- *Fresh frozen plasma:* 3 to 8 Units (mean)
- *Thrombocytes:* 0,5 for LVAD and 1,4 for TAH
- *PPSB:* if necessary to establish a basic coagulation quickly
- *REDOS:* between 29% for LVAD's and 61% for TAH

- *Additional RVAD:* One should always be prepared for additional RVAD implantation when planning LVAD's.

Summary

The implantation of assist devices is a complex operation where the anaesthesiologist has to keep in mind the different pathophysiological aspects. The treatment should be regarded as a component system where the adequate components are chosen and integrated in the therapy.

A small list of these components includes the treatment of high blood loss, coagulation disorders, pulmonary hypertension, right ventricular failure, renal failure, hepatic alterations and whatever else the patient might present. In their own entity these disorders appear sometimes during the “normal” anaesthesia, the challenge lies in the combined appearance of these problems. But I believe that when one is able to treat these disorders in the “normal” patient, one is also able to combine the relevant components and take care of the patient successfully.

References

1. Chumnanvej S et al. Perioperative echocardiographic examination for ventricular assist device implantation. *Anesthesia and Analgesia* 2007; 105 (3): 583-601
2. Mets B. Anesthesia for left ventricular assist device placement. *Journal of Cardiothoracic and Vascular Anesthesia* 2000; 14 (3): 316-26
3. Zwissler B. Acute right heart failure. Etiology – pathophysiology – diagnosis – therapy. *Der Anaesthetist* 2000; 49 (9): 788-808, doi:11076268
4. Jámbor C et al. Management of hemostasis disorders after extracorporeal circulation. A clinical therapy algorithm. *Der Anaesthetist* 2008; 57 (4): 374-81, doi:10.1007/s00101-008-1336-8
5. Levy JH, Tanaka KA, Dietrich W. Perioperative hemostatic management of patients treated with vitamin K antagonists. *Anesthesiology* 2008; 109 (5): 918-26, doi:10.1097/ALN.0b013e3181895bd8
6. Winterhalter M et al. Comparison of inhaled iloprost and nitric oxide in patients with pulmonary hypertension during weaning from cardiopulmonary bypass in cardiac surgery: a prospective randomized trial. *Journal of Cardiothoracic and Vascular Anesthesia* 2008; 22 (3): 406-13, doi:10.1053-0770(07)00325-4
7. Copeland JG et al. Cardiac replacement with a total artificial heart as a bridge to transplantation. *The New England Journal of Medicine* 2004; 351 (9): 859-67, doi:15329423
8. Kartha V et al. Laparoscopic cholecystectomy in a patient with an implantable left ventricular assist device. *British Journal of Anaesthesia* 2008; 100 (5): 652-5, doi:aen052

9. Nicolosi AC, Pagel PS. Perioperative considerations in the patient with a left ventricular assist device. *Anesthesiology* 2003; 98 (2): 565-70, doi:12552217

Address for corresponding: J.-U. Lüth, Institut für Anästhesiologie, Herz- und Diabeteszentrum NRW