Crimson Publishers
Wings to the Research

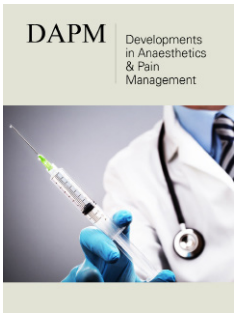
Mini Review

Right Heart Failure: Major problem after Left Ventricular Assist Device Implantation

Aykut A, Demir ZA* and Karadeniz U

University of Health Science, Ankara Bilkent City Hospital, Department of Anesthesiology, Turkey

ISSN: 2640-9399



***Corresponding author:** Z Aslı Demir, University of Health Science, Ankara Bilkent City Hospital, Department of Anesthesiology, Ankara, Turkey

Submission: August 21, 2023

Published: September 05, 2023

Volume 2 - Issue 5

How to cite this article: Aykut A, Demir ZA* and Karadeniz U. Right Heart Failure: Major problem after Left Ventricular Assist Device Implantation. Dev Anesthetics Pain Manag. 2(5). DAPM. 000546. 2023.
DOI: 10.31031/DAPM.2023.02.000546

Abstract

Right Heart Failure (RHF) can indeed be a significant concern following the implantation of a Left Ventricular Assist Device (LVAD). An LVAD is a mechanical pump that is surgically implanted to help support the function of the left ventricle. However, the use of an LVAD can have a range of effects on the heart's overall function, including its impact on the right side of the heart. When the left ventricle is assisted by an LVAD, it can sometimes lead to changes in blood flow, pressure, and overall cardiac dynamics that put strain on the right side of the heart. This strain can result in right heart failure.

Keywords: Left ventricular; Right heart failure; Right ventricular; Cardiopulmonary bypass; Pulmonary vascular resistance

Introduction

Left Ventricular Assist Devices (LVADs) are increasingly used for mechanical circulatory support in patients with severe heart failure, primarily as a bridge to heart transplantation. Right Heart Failure (RHF) is one of the most important causes of early morbidity and mortality after LVAD implantation. It is associated with prolonged intensive care and hospital stay with an incidence of 10% to 40% after LVAD implantation [1]. The pathophysiology of RHF is multifactorial, but the main cause is pulmonary vascular resistance leading to increased Right Ventricular (RV) preload, increased RV afterload with increased Left Ventricular (LV) output, or myocardial dysfunction [2]. If the right ventricle was already compromised before LVAD implantation (common in patients with advanced heart failure), the added stress from the changes in blood flow and pressures can exacerbate the dysfunction. The septum can shift due to the increased output from the LVAD and this can affect the geometry and function of the right ventricle. Besides altered blood flow dynamics created by the LVAD can lead to inadequate perfusion of the right ventricle, affecting its function over time. Right heart failure may lead to impaired LVAD flow, difficulty in weaning from cardiopulmonary bypass, decreased tissue perfusion and multiorgan failure.

Evaluation of right heart dynamics by transthoracic/transesophageal echocardiography or pulmonary artery catheterization allows us to predict right heart failure and initiate treatment while still in the preoperative and intraoperative period [3]. Echocardiography evaluates right atrium and right ventricular size, septal curvature, right ventricular systolic function, tricuspid regurgitation, right ventricular outflow tract gradient, estimated pulmonary artery pressure and right atrial pressure. Central venous filling pressure ≥15mmHg, RV Stroke Work Index (RVSWI)<0.5mmHgxL/m2, low Pulmonary Artery Pressure index (PAPi)<2.0, pulmonary capillary wedge pressure to central venous pressure ratio >0.63, signs of liver congestion and coagulopathy (eg, elevated liver enzymes or international normalized ratio), moderate to severe tricuspid regurgitation and, reduced RV systolic function by qualitative assessment or Tricuspid Annular Plane Systolic Excursion (TAPSE)<1.4cm are predictions risk factor for RHF [4-6]. The aim in the treatment of right heart failure is to obtain adequate mean arterial pressure by trying to optimize preload, contractility and afterload and to

maintain sinus rhythm. Fluid therapy is important in these patients and if there are signs of systemic congestion, aggressive diuresis or venovenous hemodialysis should be performed to decrease the afterload. Keeping the central venous pressure below 15mmHg prevents right ventricular overload and reduces hepatic and renal congestion [7]. Maintenance of RA pressure below 18mmHg after LVAD implantation decreases the possibility of RHF [8]. There are some important poits to decrease pulmonary vascular resistance which are providing adequate ventilation to prevent hypoxia and hypercarbia during the perioperative period and correction of acid-base disorders. In addition, optimization of temperature and prevention of coagulopathy are necessary.

Although beta-blockers and angiotensin converting enzyme inhibitors are beneficial for left ventricular dysfunction in medical treatment, milrinone, levosimendan and dobutamine are known to be more effective for improving the right ventricle function. Inhaled Nitric Oxide (iNO) is a selective pulmonary vasodilator that successfully reduces pulmonary vascular resistance. iNO initiated before weaning from cardiopulmonary bypass and continued until 48 hours later has been shown to reduce Mean Pulmonary Artery Pressure (mPAP) and increase LVAD flow [9]. It is even considered to be started prophylactically in patients who will undergo LVAD implantation to relieve right ventricular function [10]. In cases that cannot be managed despite all optimizations and medical therapies (4-6%), Extracorporeal Membrane Oxygenation (ECMO) has proven to be valuable by supporting hypoxic patients and allowing peripheral cannulation [11]. However, ECMO also has a high rate of complications such as bleeding, thromboembolism, hemolysis, anemia, and increased need for transfusion. Other surgical methods such as temporary right ventricular assist device (RVAD, Biomedicus or Tandem Life), percutaneous devices (Impella RP® Abiomed) and TandemHeart are devices that have been shown to be successful in survival in right heart failure [12,13]. Because of its increasing use as a bridge to destination therapy or transplantation in patients with end-stage heart failure, the LVAD has often been the domain of cardiovascular anesthesiologists. Preoperative evaluation, anticipation, early diagnosis and intraoperative management and appropriate treatment planning are important for RHF in LVAD patients.

References

1. Konstam MA, Kiernan MS, Bernstein D, Bozkurt B, Jacob M, et al. (2018) Evaluation and management of right-sided heart failure: A Scientific statement from the american heart association. Circulation 137(20): e578-e622.
2. Ali HR, Kiernan MS, Choudhary G, Levineet DJ, Sodha NR, et al. (2020) Right ventricular failure post-implantation of left ventricular assist device: Prevalence, pathophysiology, and predictors. ASAIO J 66(6): 610-619.
3. Haddad F, Couture P, Tousignant C, Denault AY (2009) The right ventricle in cardiacsurgery, a perioperative perspective: II. pathophysiology, clinical importance, and management. Anesth Analg 108(2): 422-433.
4. Kang G, Ha R, Banerjee D (2016) Pulmonary artery pulsatility index predicts right ventricular failure after left ventricular assist device implantation. J Heart Lung Transplant 35(1): 67-73.
5. Kormos RL, Teuteberg JJ, Pagani FD, Russell SD, John R, et al. (2010) Right ventricular failure in patients with the HeartMate II continuous-flow left ventricular assist device: Incidence, risk factors, and effect on outcomes. J Thorac Cardiovasc Surg 139(5): 1316-1324.
6. Raymer DS, Moreno JD, Sintek MA, Nassif ME, Sparrow CT, et al. (2019) The combination of tricuspid annular plane systolic excursion and heartmate risk score predicts right ventricular failure after left ventricular assist device implantation. ASAIO J 65(3): 247-251.
7. Fida N, Loebe M, Estep JD, Guha A (2015) Predictors and management of right heart failure after left ventricular assist device implantation. Methodist Debakey Cardiovasc J 11(1): 18-23.
8. Argiriou M, Kolokotron SM, Sakellaridis T, Argiriou O, Charitos C, et al. (2014) Right heart failure post left ventricular assist device implantation. J Thorac Dis 6: 52-59.
9. Kukucka M, Potapov E, Stepanenko A, Mladenow A, Weller K, et al. (2011) Acute impact of left ventricular unloading by left ventricular assist device on the right ventricle geometry and function: Effect of nitric oxide inhalation. J Thorac Cardiovasc Surg 141(4): 1009-1014.
10. Potapov E, Meyer D, Swaminathan M, Ramsay M, Banayosy AE, et al. (2011) Inhaled nitric oxide after left ventricular assist device implantation: A prospective, randomized, double-blind, multicenter, placebo-controlled trial. J Heart Lung Transplant 30(8): 870-878.
11. Scherer M, Sirat AS, Moritz A, Martens S (2011) Extracorporeal membrane oxygenation as perioperative right ventricular support in patients with biventricular failure undergoing left ventricular assist device implantation. Eur J Cardiothorac Surg 39(6): 939-944.
12. Kapur NK, Esposito ML, Bader Y, Morine KJ, Kiernan MS, et al. (2017) Mechanical circulatory support devices for acute right ventricular failure. Circulation 136(3): 314-326.
13. Cheung AW, White CW, Davis MK, Freed DH (2014) Short-term mechanical circulatory support for recovery from acute right ventricular failure: Clinical outcomes. J Heart Lung Transplant 33(8): 794-799.