Prevention and Treatment of Right Ventricular Failure During Left Ventricular Assist Device Therapy

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KEYWORDS

• Left ventricular assist device • Right ventricular failure • Morbidity • Mortality
• Risk stratification • Treatment • Prevention

KEY POINTS

- Right ventricular failure is a frequently encountered clinical problem due to the increasing utilization of left ventricular assist devices (LVADs) for end-stage heart failure and expansion of the patient population eligible for LVAD therapy.
- The true incidence of right ventricular failure post-LVAD implantation has been challenging to define because of varying definitions in the literature and switch from pulsatile to continuous flow technology.
- Postoperative right ventricular failure may be predicted by preoperative clinical, hemodynamic, and imaging variables, which have been combined into a variety of risk prediction algorithms, although right ventricular failure may also develop due to unanticipated intraoperative and postoperative factors.
- Early recognition of right ventricular failure is critical because early institution of medical therapy for right heart failure and/or right ventricular mechanical circulatory support is associated with superior outcomes versus delayed treatment.
- Randomized clinical trial data are needed to support the use of specific medical and device therapy in patients with right ventricular failure post-LVAD implant.

INTRODUCTION

Left ventricular assist devices (LVAD) are used with increasing frequency in patients with heart failure with reduced ejection fraction (HFrEF) and advanced heart failure

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(HF) symptoms despite maximally tolerated medical therapy.[1] Improvements in device design with smaller continuous flow (CF) pumps have improved device durability, and newer centrifugal pumps hold the promise of reducing serious adverse events, such as pump thrombosis.[2,3] With the increasing utilization of CF LVAD therapy and expansion of the patient population potentially eligible for LVAD implantation, right ventricular (RV) failure after LVAD implantation is more commonly encountered in clinical practice. The true incidence of RV failure after LVAD implantation is difficult to firmly establish because of varying definitions of RV failure in single-center studies and the shift from utilization of pulsatile to CF devices. Thus, estimates of the incidence of RV failure vary widely over a range from 10% to 40%.[4–7]

Severe RV failure after LVAD implantation and particularly requirement with a right ventricular assist device (RVAD) is associated with a substantial increase in morbidity and mortality and less successful bridging to cardiac transplantation.[1,5,6,8,9] Given that more LVAD patients with RV failure will be encountered clinically and the substantial impact RV failure has on LVAD outcomes, an important ongoing focus will be on strategies to identify and ideally prevent RV failure. In those patients who do develop RV failure, developing a treatment paradigm to improve outcomes remains a focus of discussion and continued research. In turn, a thorough understanding of mechanisms that are involved in the development of RV failure is required in order to prevent and treat it. This article reviews the following:

- The physiology underlying the development of RV failure in LVAD patients
- Established RV failure risk prediction algorithms
- Intraoperative and postoperative measures to try to prevent RV failure
- Management of patients who develop RV failure despite preoperative risk stratification, medical optimization, and aggressive perioperative treatment

DEFINITION OF RIGHT VENTRICULAR FAILURE

RV failure after LVAD implantation has been challenging to consistently define in the literature because there have been a variety of definitions in different single-center studies and most RV failure has been defined in relation to the index hospitalization for LVAD implant. The most consistently used and updated definition from the INTERMACs database characterizes RV failure as mild, moderate, or severe/severe-acute predominantly based on signs of elevated central venous pressure (CVP) and duration of inotropic/vasodilator support, need for RVAD implant, or death from RV failure after LVAD implant.[1] However, there is increasing recognition of a subset of patients who survive the index LVAD hospitalization without meeting criteria for severe RV failure but who subsequently present much later in their clinical course with symptomatic RV failure. These patients with “late” RV failure also have substantially increased morbidity and mortality.[10,11]

MECHANISMS OF RIGHT VENTRICULAR FAILURE

The development of RV failure can occur for a variety of reasons: some secondary to patient-related factors evident before LVAD implantation, others due to factors occurring during the intraoperative or perioperative course and additional issues that develop in the immediate postoperative period.

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