Improved Early Survival With a Nonsternotomy Approach for Continuous-Flow Left Ventricular Assist Device Replacement

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Background. Even in the modern era of continuous-flow left ventricular assist devices (CF LVADs), device replacement may be required. Nonsternotomy (NS) approaches are being used more commonly for replacement procedures. Outcomes after this less invasive approach compared with those after a reoperative sternotomy (RS) have not been extensively studied. Furthermore, the clinical impact of concurrent cardiac procedures during device replacement has not been examined.

Methods. From 2005 to 2013, all consecutive implantable LVAD procedures were reviewed, and those using CF devices as both the initial and replacement device were identified. These CF LVAD replacement procedures were divided into those using an RS and those using an NS approach. Periprocedural morbidity and mortality were compared between the groups.

Results. A total of 42 CF LVAD replacements were performed in 39 patients, with 20 using an RS approach and 22 using an NS approach. Eleven of the 20 replacement procedures performed by RS included a concurrent cardiac procedure. Relative to the RS cohort, the NS approach was associated with shorter cardiopulmonary bypass time, reduced length of mechanical ventilation, decreased transfusion requirements, less inotropic support, decreased incidence of right ventricular (RV) dysfunction, and shorter intensive care unit (ICU) and overall hospital stays. An NS approach was also associated with improved 30- and 90-day survival (100% versus 79.0% in the RS group; $p = 0.048$). RS replacement procedures appeared to be associated with increased morbidity, regardless of whether they included concurrent cardiac procedures.

Conclusions. Patients who did not require an RS approach and who underwent CF LVAD replacement through an NS approach had improved survival and reduced morbidity compared with those who required an RS.

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Continuous-flow left ventricular assist devices (CF LVADs) have been shown to have greater durability compared with older generation pulsatile devices [1]. Nevertheless, CF LVADs still may require replacement for conditions such as thrombosis/hemolysis, infection, or electrical failure [2, 3], and a larger experience with such complications is being reported [1, 4, 5]. Previously, we reported substantial morbidity and mortality associated with device replacement by traditional reoperative sternotomy (RS) [2]. This increased procedural risk may result from the RS in combination with impaired right ventricular (RV) function and coagulopathy inherent to CF LVADs. The modular design of the CF LVADs, however, enables nonsternotomy (NS) replacement of the pump and power cord with retention of the original outflow conduit in the retrosternal location. In an effort to improve procedural morbidity and mortality, surgeons have adopted an NS approach to device replacement [6, 7]. The basic conduct of these replacements requires either a small anterior thoracotomy or a subcostal incision combined with peripheral cardiopulmonary bypass and some method to control retrograde bleeding from the outflow conduit [6]. We have reserved RS approaches for cases in which the outflow graft of the existing device definitely requires replacement. In addition, RS was used for cases in which significant tricuspid or aortic insufficiency (AI), or both, was identified, and the replacements were performed with a concurrent valvular procedure. In this report, early outcomes and procedural adverse events are compared for replacements conducted with an RS versus an NS approach.

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Abbreviations and Acronyms

AI = aortic insufficiency
CF LVAD = continuous-flow left ventricular assist device
NS = nonsternotomy
RS = reoperative sternotomy
TR = tricuspid regurgitation

Patients and Methods

The Duke University Institutional Review Board approved the study protocol, and the requirement for patient consent was waived. The medical records of all patients who received an implantable LVAD at Duke University Medical Center from January 2005 to August 2013 were reviewed. The replacement group consisted of all consecutive patients during this period who underwent a CF LVAD replacement procedure, defined as removal of an implanted CF LVAD system and insertion of another CF LVAD. All consecutive cases meeting this definition were included in this study. Replacements involving first-generation pulsatile devices or extracorporeal LVADs were specifically excluded.

Once the study group was established, baseline patient characteristics were collected, including age; sex; race; cause of heart failure; the presence of concurrent diabetes, hypertension, peripheral vascular disease, and pulmonary disease (decreased pulmonary function requiring medication); preprocedural hemodynamics, albumin levels, renal function, presence of anemia or coagulopathy; and the need for preprocedural inotropic support, intraaortic balloon support, or mechanical ventilation. The medical records were reviewed to determine and categorize cases as emergent or nonemergent. An emergent procedure was defined as one that was performed during nonelective operative time or one in which the patient's American Society of Anesthesiologist physical status class was designated as "E," or both.

The operative notes were reviewed to determine whether an RS or NS approach was used for the CF LVAD replacement. The NS approach group consisted of those patients who underwent a replacement procedure through either a small left subcostal or anterior thoracotomy incision. All NS HeartMate II (Thoratec Corp, Pleasanton, CA) to HeartMate II replacements were performed through a 5-inch subcostal incision. All NS HVAD (HeartWare International, Inc, Framingham, MA) to HVAD replacements were performed through a left anterior thoracotomy of similar length. All other patients underwent replacement through a standard RS, and replacements (4 cases) in which the device type was changed (eg, HVAD to HeartMate II) were all conducted through an RS. The technical aspects of these approaches

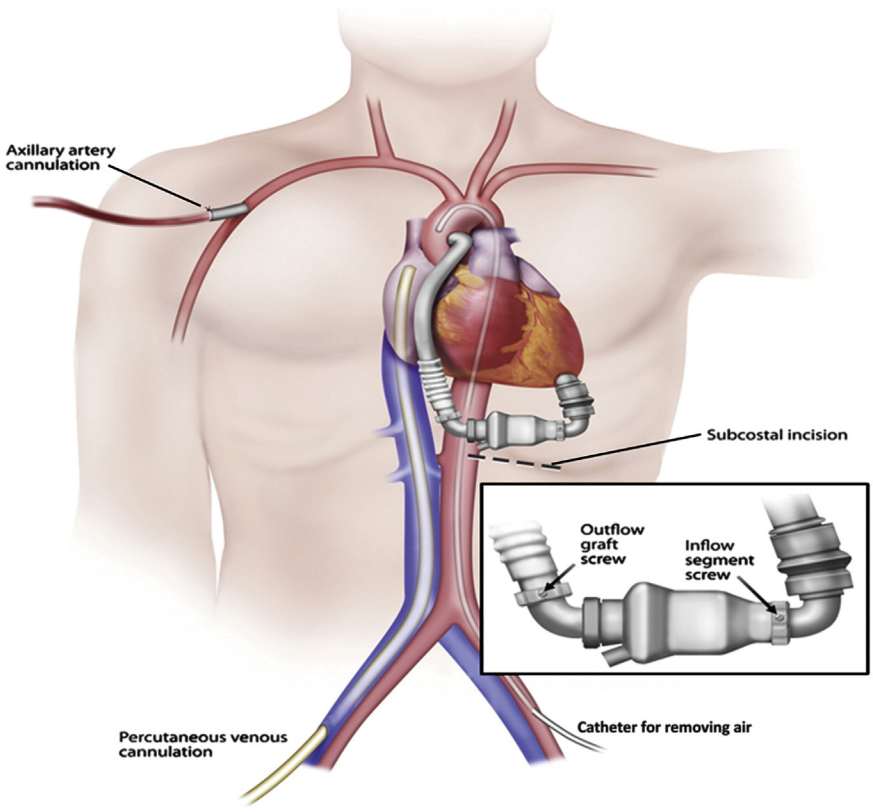

Fig 1. Surgical setup for continuous-flow left ventricular assist device (CF LVAD) replacement through a small left subcostal incision. Right axillary artery and right femoral vein are used to establish cardiopulmonary bypass. Catheter to remove air is introduced through left femoral artery and guided into ascending aorta. Finally, balloon catheter is used to control back bleeding after disconnection of outflow graft.