ELSEVIER

Importance of Early Appropriate Intervention Including Antibiotics and Wound Care for Device-Related Infection in Patients With Left Ventricular Assist Device

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ABSTRACT

Introduction. A left ventricular assist device (LVAD) is essential for treating patients with advanced heart failure. However, LVAD-related infection is a significant cause of mortality and morbidity, with bloodstream infection (BSI) especially associated with high mortality. We investigated the incidence of infectious complications in patients who received an LVAD and evaluated the effects of early and appropriate intervention for LVAD-related infection.

Method. We retrospectively reviewed 27 consecutive patients who underwent continuous-flow LVAD (CF-LVAD; n = 16) or pulsatile-flow LVAD (PF-LVAD; n = 11) implantation at the National Cerebral and Cardiovascular Center between April 2011 and March 2013. Incidences of LVAD-related infections, such as drive-line infection in patients with CF-LVAD, cannula infection in patients with PF-LVAD, and BSI in patients with both types, were examined (follow-up period, 342 ± 229 days). The mandatory antibiotic prophylaxis protocol at our institution includes teicoplanin (400 mg) 2 days before LVAD implantation and doripenem (1000 mg) within 1 hour of skin incision. In addition, the driveline exit sites undergo sterile cleansing with diluted hydrogen peroxide and placement of an antimicrobial occlusive dressing for wound care, with dressing changes performed 2–3 times per day.

Results. More than 90% of all patients suffered from a drive-line infection within 12 months after LVAD implantation. However, BSI developed in only 12.5% of CF-LVAD and 10% of PF-LVAD patients within 12 months (log-rank test; $P = .875$).

Conclusions. LVAD-related infections, such as drive-line and cannula infections, were common, whereas the incidence of BSI was low in our LVAD-implanted patients. Our results highlight the importance of early and appropriate intervention including antibiotics and wound care for device-related infections for reducing the incidence of potentially fatal BSI.

A LEFT ventricular assist device (LVAD) has become an essential therapeutic option for management of advanced heart failure. However, several important clinical issues remain to be resolved. LVAD-related infection can be a serious clinical issue for LVAD patients, with bloodstream infection (BSI) showing the highest incidence of mortality [1,2]. Findings from the REMATCH (Randomized Evaluation of Mechanical Assistance for the Treatment of Congestive Heart Failure) trial revealed that BSI was the leading cause of death in LVAD patients and accounted for 41% of all deaths [3]. Also, in the HeartMate II bridge-to-transplant study, BSI affected 20% of patients with a continuous-flow device and accounted for 20% of deaths occurring within 6 months [4]. The etiology of device-related infection is multi-factorial. In addition to drive-line surface characteristics, patient comorbidities, nature of the infecting micro-organism (virulence and ability to form biofilm), and perioperative and postoperative care (eg, administration of appropriate antibiotics and wound care) play important roles [5].

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0041-1345/14/$–see front matter
http://dx.doi.org/10.1016/j.transproceed.2013.11.106

A device-related infection is a common complication that can affect heart transplantation and is also a major cause of death. In the present study, we investigated the incidence of infectious complications in patients who received a continuous-flow implantable LVAD (CF-LVAD) or pulsatile-flow extra-corporeal LVAD (PF-LVAD) as a bridge to heart transplantation. In addition, we evaluated the effects of early and appropriate intervention, including antibiotics and wound care, on LVAD-related infection.

METHODS

Study Design

We retrospectively reviewed 27 consecutive patients who received implantation of a PF-LVAD (n = 11) or CF-LVAD (n = 16) at the National Cerebral and Cardiovascular Center between April 2011 and March 2013. Variables examined included demographics (age and gender) and the etiology of heart failure, whereas the incidences of BSI and drive-line infection were also investigated (follow-up period, 342 ± 229 days), with organisms obtained from bloodstream samples used to assess drive-line infections in more detail. The study protocol was approved by the Ethics Committee of our institution.

Outcome Definitions

The criteria used for infection were clinical infection accompanied by pain, fever, drainage, and/or leukocytosis treated using antimicrobial agents. A positive culture from the infected site, organ, or blood was required unless strong clinical evidence indicated the need for treatment despite negative culture findings.

We referred to the criteria of the American College of Chest Physicians and Society of Critical Care Medicine (ACCP/SCCM) for treating BSIs, which state that the following 2 or more conditions be found: (1) temperature > 38°C or < 36°C, (2) heart rate > 90 beats/min, (3) respiratory rate > 20 breaths/min or $PaCO_2$ < 32 mm Hg, and (4) white blood cell count 12,000 cells/mm^3, 4000 cells/mm^3, or 10% immature bands resulting from a confirmed infectious process [6]. In addition, using the Hospital Infection Control Practices Advisory Committee (HICPAC) surgical site infection criteria template, drive-line (and LVAD pocket) infections were defined as either: (1) purulent drainage from the drive-line exit site (or device pocket), (2) organisms isolated from an aseptically obtained culture of fluid or tissue from the drive-line exit site (or device pocket), or (3) abscess or other evidence of infection involving the drive-line tract (or device pocket) found on direct examination, during reoperation, or in a histopathologic or radiological examination [7].

Statistical Analysis

Baseline clinical characteristics were assessed using Wilcoxon test for continuous variables, with a chi-square test used for categorical variables. Kaplan-Meier estimates of freedom from infectious complications were performed for first analyzing bloodstream and drive-line infections in the overall cohort by device type. Then those results were compared using a log-rank test. For all analyses, P <.05 was considered to indicate statistical significance. Analyses were conducted using JMP software, version 10 (SAS Institute Inc., Cary, North Carolina, United States).

Culture Protocol and Wound Care

The mandatory antibiotic prophylaxis protocol at our institution includes teicoplanin (400 mg) 2 days before LVAD implantation and doripenem (1000 mg) within 1 hour of skin incision. Antibiotic drugs are redosed based on their pharmacokinetic properties in the operation room. Doripenem (1000 mg, 3 times daily) is administered until extubation after sterna closure, whereas teicoplanin (400 mg, once daily) and micafungin (150 mg, once daily) are administered until healing of the wound. Furthermore, routine cultures are performed within 1 week from the day of LVAD implantation, with additional cultures done where there is clinical suspicion of infection, pain in the exit site, acute neutropenia or leukocytosis, or temperature <36°C or >38°C.

Naturally, we consider that careful sterile management of the exit site is important. The drive-line exit sites receive sterile cleansing with diluted hydrogen peroxide and placement of an antimicrobial occlusive dressing for wound care, with dressing changes performed 2–3 times per day. All LVAD-related infections are treated with adequate systemic antibiotics including teicoplanin, vancomycin and linezolid as soon as possible and for the proper dosing periods. Early de-escalation of antimicrobials, based on Gram staining of an exit site sample and blood culture results, is performed. Antibiotics are dosed according to renal function when appropriate.

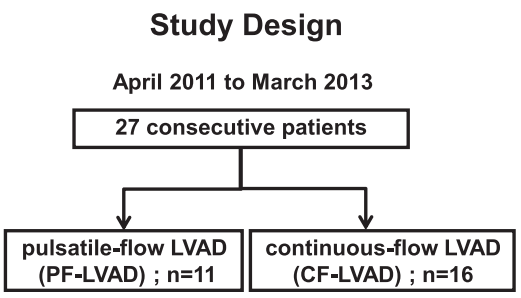

Fig 1. Study design.

RESULTS

Infectious Outcomes

Sixteen patients received a CF-LVAD and 11 a PF-LVAD during the study period (Fig 1). The follow-up period for the present patients was 342 ± 229 days. Baseline clinical characteristics were similar between the groups (Table 1).

Infectious event-free days stratified by device type were reviewed for BSI and drive-line–related infection (Fig 2). Although nearly all patients in both groups suffered from an

Table 1. Baseline Characteristics of Patients Stratified by LVAD Type

	PF-LVAD (n = 11)	CF-LVAD (n = 16)	*P*
Age (y)	34.6 ± 9.6	37.5 ± 11.9	.51
Gender	Male: 7 (63.6%)	Male: 16 (100%)	.0188
DCM	6 (54.5%)	9 (56.3%)	.93
dHCM	2 (18.2%)	1 (6.3%)	.35
ICM	1 (9.1%)	3 (18.8%)	.51
2nd CM	1 (9.1%)	3 (18.8%)	.51
PPCM	1 (9.1%)	0 (0%)	.23
Follow-up (d)	277 ± 182	387 ± 228	.23

Note: Comparisons between 2 groups were done using Wilcoxon test or a chi-square test, with P < .05 considered to be significant.

Abbreviations: DCM, dilated cardiomyopathy; dHCM, dilated-phase hypertrophic cardiomyopathy; ICM, ischemic cardiomyopathy; 2nd CM, secondary cardiomyopathy; PPCM, peripartum cardiomyopathy.