a simple and not very costly operation with a relatively fast recovery.

In conclusion, the advantages of this 2-stage surgical technique are the reduction of the extent and costs of the second-stage operation along with the advantages of reconstruction with a gastric tube via the posterior mediastinum.

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Comparisons of infection complications between continuous flow and pulsatile flow left ventricular assist devices

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The implantation of a left ventricular assist device (LVAD) both as a bridge to transplantation and as destination therapy is being used with increasing frequency in patients with end-stage heart failure. Two main types of LVADs are currently being used: pulsatile and continuous flow devices. Continuous devices are much smaller and produce a continuous flow with either an axial or centrifugal flow pump. These devices fill during both the systolic and diastolic phase.[1]

Despite the overall success of LVAD support and the advances in design in both types of devices, infection continues to be a common morbidity of mechanical circulatory support and remains a serious threat to the long-term survival of patients using LVADs.[2,3] This study was designed to determine the differences in infection rates between patients with puslatile pumps (HeartMate I; Thermo Cardiosystems, Inc, Woburn, Mass) versus those with axial flow devices (HeartMate II or DeBakey; MicroMed Technology, Inc, Houston, Tex).

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Patients and Methods

We retrospectively reviewed the case histories of 92 patients undergoing LVAD implantation at a single center between October 2003 and April 2006. This analysis captured the first 27 axial flow device implants at our center, as well as every HeartMate I device implanted during the same interval. LVADs were classified as pulsatile (n = 65) or continuous flow (n = 27). Local device infection was defined by clinical signs of infection with positive culture(s) from the abdominal wound, driveline, pocket, or pump. The χ^2 test was used to analyze the associations between device type and categorical variables (device infections, gender, preoperative history of diabetes or hypertension, bridge-to-transplant rate, and post-implant 1-year survival), and the nonparametric Mann–Whitney test was used to analyze associations between device type and continuous variables (age, height, body surface area [BSA], and body mass index [BMI]).

Results

Findings are summarized in Table 1. There were no significant differences between pulsatile and continuous device groups with respect to age, gender, height, or preoperative history of diabetes or hypertension. BSA (2.0 vs 1.89; $P = .035$) and BMI (28.6 vs 24.9; $P = .009$) were significantly higher in patients with pulsatile devices. Patients with pulsatile devices were more likely to have an LVAD-related infection (18/65 vs 1/27, 27.7% vs 3.7%; $P = .010$), in particular pocket infections (10/65 vs 0/27, 15.4% vs 0%; $P = .031$) and wound infections (10/65 vs 0/27, 15.4% vs 0%; $P = .031$). Of note, the rates of driveline infection (9/65 vs 2/27, 13.8% vs 7.4%; $P = .271$) and pump endocarditis (2/62 vs 1/26, 3.2% vs 3.7%; $P = .999$) were comparable between the two groups. Device infections had no effect on bridge-to-transplant rate (15/18 vs 39/56, 83.3% vs 69.6%; $P = .364$) or

TABLE 1. Demographic profile and infection rates for all patients with left ventricular assist devices (LVADs)

Variable	Pulsatile devices (n = 65)	Axial flow devices (n = 27)	*P* value
Demographic			
Age (y)	51.8 ± 13.3	55.1 ± 12.8	NS
Female	10/65 (15.4%)	5/27 (18.5%)	NS
Height (cm)	174.5 ± 8.6	173.7 ± 8.5	NS
Weight (kg)	87.0 ± 20.0	75.2 ± 17.7	.016
BMI	28.6 ± 6.1	24.9 ± 5.5	.009
BSA	2.0 ± 0.3	1.89 ± 0.25	.035
Diabetes	20/65 (30.8%)	10/27 (37.0%)	NS
Hypertension	24/65 (36.9%)	9/27 (33.3%)	NS
MCS (d)	133.6 ± 124.1	130.1 ± 117.8	NS
Infection type			
LDI	18/65 (27.7%)	1/27 (3.7%)	.010
Driveline	9/65 (13.8%)	2/27 (7.4%)	NS
Pocket	10/65 (15.4%)	0/27 (0%)	.031
Wound	10/65 (15.4%)	0/27 (0%)	.031
Bacteremia	17/65 (26.2%)	7/27 (25.9%)	NS
Pump endocarditis	2/62 (3.2%)	1/27 (3.7%)	NS
Sepsis	6/62 (9.7%)	1/26 (3.8%)	NS

BMI, Body mass index; *BSA,* body surface area; *MCS,* mechanical circulatory support; *LDI,* local device infection; *NS,* not significant.

postimplant 1-year survival (13/19 vs 50/71, 68.4% vs 70.4%; $P = .999$) in either group.

Discussion

Differences in infection rates between pulsatile and continuous flow LVADs may be a reflection of differences in device design. Continuous flow devices are smaller and do not have compliance chambers, polyurethane membranes, or prosthetic valves that pulsatile devices have.[4] The larger implanted surface and the pooling of fluid that may surround the pulsatile devices promote microbial adhesion and growth.[2] Furthermore, continuous flow devices need only a small pump pocket and do not require a great deal of surgical dissection. These characteristics collectively may explain the low infection rate. This difference in device size underlies the significant difference in BMI and BSA between the two groups; smaller patients who are not candidates for the HeartMate I LVAD are often able to accommodate the comparatively smaller continuous flow pumps.

Results from this single-center analysis support the hypothesis that continuous flow LVADs have reduced infection rates. Surprisingly, there was no difference in pump endocarditis. Perhaps this can be attributed to a definition of infection that is too stringent—broad-spectrum antibiotic use may suppress bacterial growth and lead to false negative cultures in the setting of true device infection. Alternatively, this finding may reflect improved infection control in the post-REMATCH* era. Optimal implantation techniques, tight glucose control, and meticulous surgical site care may all contribute to decreased LVAD infection rates.

It is not surprising that there is no significant difference in driveline infection rates between pulsatile and continuous flow LVADs, because both devices require an abdominal exit site that connects the pump to an external power source. The high incidence of driveline infection in the literature highlights the importance of improving on currently used technology. Furthermore, deep driveline tract infections often result in pocket and/or device infections that may be refractory to medical treatment.[5] Further development of transcutaneous energy transmission systems may further reduce infection rates by eliminating the need for drivelines.

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*REMATCH = Randomized Evaluation of Mechanical Assistance for the Treatment of Congestive Heart Failure.