
The use of biventricular assist devices in end stage chronic heart failure

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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LIST OF ABBREVIATIONS AND ACRONYMS USED IN THIS THESIS

Abbreviation	Full term
AHA	American Heart Association
AoP	Aortic pressure
AR	Aortic regurgitation
ASAIO	American Society of Artificial Internal Organs
BMI	Body mass index
BiVAD	Biventricular assist device
BiVF	Biventricular failure
BP	Blood pressure
BTB	Bridge to bridge
BTR	Bridge to recovery
BTT	Bridge to transplant
CDAS	Continuous Data Acquisition System
cfBiVAD	Continuous flow biventricular assist device
cfLVAD	Continuous flow left ventricular assist device
cfTAH	Continuous flow total artificial heart
cfVAD	Continuous flow ventricular assist device
CHF	Chronic heart failure
CO	Cardiac output
CVP	Central venous pressure
DCM	Dilated cardiomyopathy
ECMO	Extracorporeal membrane oxygenation
FDA	Food and Drug Administration
HR	Heart rate
HVAD	HeartWare Ventricular Assist Device
IABP	Intra-aortic balloon pump
ICU	Intensive care unit
INTERMACS	Interagency Registry for Mechanically Assisted Circulatory Support
IQR	Interquartile range
IVAD	Intracorporeal ventricular assist device
LA	Left atrium
LAP	Left atrial pressure
LDH	Lactate dehydrogenase

LoS	Length of stay
LVAD	Left ventricular assist device
LV	Left ventricle
LVP	Left ventricular pressure
MAP	Mean arterial pressure
MCL	Mock circulatory loop
MCSD	Mechanical Circulatory Support Device
MPAP	Mean pulmonary arterial pressure
MR	Mitral regurgitation
MVAD	Miniaturized ventricular assist device
NYHA	New York Heart Association
PA	Pulmonary artery
PAP	Pulmonary artery pressure
PVAD	Paracorporeal ventricular assist device
PVC	Poly-vinyl
PVR	Pulmonary vascular resistance
RAP	Right atrial pressure
RNA	Ribonucleic acid
RV	Right ventricle
RVAD	Right ventricular assist device
RVF	Right ventricular failure
RVP	Right ventricular pressure
SD	Standard deviation
SOFA	Sequential Organ Failure Assessment
SPSS	Statistical Software Package for the Social Sciences
SVR	Systemic vascular resistance
TAH	Total Artificial Heart
TET	Transcutaneous energy transfer
TR	Tricuspid regurgitation
UK	United Kingdom
USA	United States of America
VAD	Ventricular Assist Device
VA-ECLS	Veno-arterial extracorporeal life support
VPA-ECLS	Veno-pulmonary arterial extracorporeal life support

ABSTRACT

Patients with severe biventricular failure are often supported with early generation paracorporeal biventricular assist devices (BiVAD). Compared to durable continuous flow left ventricular assist devices (LVAD), these pulsatile BiVAD systems are decades behind in terms of both design and performance. Therefore the aim of this thesis was to assess the use of two continuous flow LVADs (HeartWare HVAD) for biventricular support. Various aspects of this novel BiVAD system were tested. Pump performance and haemodynamic characteristics were tested using an in-vitro model of the human cardiovascular system, clinical short and long term outcomes were retrospectively reviewed in 14 patients (10 over the course of this thesis), and laboratory assessment was undertaken to evaluate the consequences of BiVAD support on the patients cardiac parameters, particularly on the genetic variations of cardiomyocytes in 7 paired samples (implant vs. explant). Our in-vitro simulations revealed that dual LVAD therapy (BiVAD with two LVADs) was an acceptable form of biventricular support. Interestingly, from a haemodynamic viewpoint, post-LVAD induced right ventricular failure was successfully reversed with delayed RVAD support. In addition, our experiments also revealed successful BiVAD support despite the presence of mitral or tricuspid regurgitation. Our clinical investigations depicted acceptable 1 year survival and high transplantation rates. It also demonstrated an innovative methodology of implanting LVAD in both the right ventricle and right atrium for right ventricular support. The laboratory findings resulted in the development of sound methodology and application of investigatory techniques. However, no differences were found between the up/down regulation of genetic markers pre- and post BiVAD support. Further research in the area is warranted. In conclusion, the use of dual LVAD therapy is an acceptable means of providing durable BiVAD support in patients unsuitable for isolated LVAD therapy.