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Original Article

# Short-term CentriMag® Support in INTERMACS 1–2 Cardiogenic Shock: Lessons from A Single-Center Experience

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## Abstract

**Objective:** Acute cardiogenic shock (CS) developing in the setting of chronic heart failure is associated with high mortality and requires rapid hemodynamic intervention. This study aimed to evaluate the early outcomes of patients who received short-term mechanical circulatory support with the CentriMag® system for refractory CS and to assess the effectiveness of this strategy as a bridge therapy.

**Methods:** This retrospective, single-center study included 30 consecutive patients who had been listed for heart transplantation and underwent CentriMag® short-term ventricular assist device (VAD) implantation due to the development of CS between September 2010 and December 2013 in our hospital. CS was defined as persistent low cardiac output despite inotropic therapy and intra-aortic balloon pump support. The primary endpoints were survival to hospital discharge and successful bridging to recovery, durable support, or heart transplantation. Secondary endpoints included hemodynamic and laboratory improvement as well as device-related complications.

**Results:** The mean age of the patients was 32.7±15.2 years, and 70% were male. The mean left ventricular ejection fraction was 20.1%±4.0%. The most common etiologies of CS were idiopathic dilated cardiomyopathy (36.7%) and ischemic cardiomyopathy (26.7%). The most frequent post-operative complications were arrhythmia (36.6%), acute kidney injury (40%), and infection (33.3%). The mean duration of support was 33 days (range, 4–185). Eight patients (26.7%) were successfully bridged to heart transplantation and four (13.3%) to durable VAD support, while the 30-day survival rate was 60%.

**Conclusion:** The CentriMag® short-term VAD provided effective hemodynamic stabilization, improved end-organ function, and enabled bridging to durable support or heart transplantation in a substantial proportion of patients with refractory CS. Despite the high complication rates inherent in this critically ill population, the survival outcomes were more favorable compared with conventional therapy. The CentriMag® system appears to be a reliable bridge-to-decision or bridge-to-transplant option for patients with advanced heart failure presenting with acute CS.

**Keywords:** Cardiogenic shock; CentriMag; heart failure; mechanical circulatory support; ventricular assist device.

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# INTERMACS 1–2 Kardiyojenik Şokta Kısa Dönem CentriMag® Desteği: Tek Merkez Deneyimi

## Özet

**Amaç:** Kronik kalp yetersizliği (KKY) zemininde gelişen akut kardiyojenik şok (KŞ), yüksek mortalite ile ilişkilidir ve hızlı hemodinamik müdahale gerektirir. Bu çalışma, refrakter KŞ nedeniyle CentriMag® sistemi ile kısa dönem mekanik dolaşım desteği (MDD) uygulanan hastaların erken dönem sonuçlarını değerlendirmeyi ve bu stratejinin köprüleme tedavisi olarak etkinliğini incelemeyi amaçladı.

**Yöntem:** Bu retrospektif, tek merkezli çalışma, Eylül 2010 ile Aralık 2013 tarihleri arasında hastanemizde kardiyojenik şok (KŞ) gelişimi nedeniyle CentriMag® kısa dönem ventrikül destek cihazı (VAD) implantasyonu yapılan ve kalp nakli listesinde yer alan ardışık 30 hastayı içermektedir. KŞ, inotrop tedavi ve intraaortik balon pompası (İABP) desteğine rağmen devam eden düşük kardiyak debi olarak tanımlandı. Birincil sonlanım noktaları; hastaneden taburculuğa kadar sağkalım ve iyileşmeye, kalıcı desteğe veya kalp nakline başarılı köprüleme idi. İkincil sonlanım noktaları; hemodinamik ve laboratuvar iyileşmesi ile cihazla ilişkili komplikasyonları içeriyordu.

**Bulgular:** Hastaların ortalama yaşı 32,7±15,2 yıl olup, %70'i erkekti. Ortalama sol ventrikül ejeksiyon fraksiyonu %20,1±4,0 idi. KŞ'nin en yaygın etiyolojileri idiyopatik dilate kardiyomiyopati (%36,7) ve iskemik kardiyomiyopati (%26,7) olarak saptandı. En sık postoperatif komplikasyonlar aritmi (%36,6), akut böbrek hasarı (%40) ve enfeksiyon (%33,3) idi. Ortalama destek süresi 33 gün (4–185 gün aralığı) idi. Sekiz hasta (%26,7) başarılı şekilde kalp nakline ve dört hasta (%13,3) kalıcı VAD desteğine köprülendi; 30 günlük sağkalım oranı ise %60 idi.

**Sonuç:** CentriMag® kısa dönem VAD, etkili hemodinamik stabilizasyon sağladı, organ fonksiyonlarında iyileşme oluşturdu ve refrakter KŞ olan hastaların önemli bir kısmında kalıcı desteğe veya kalp nakline köprülemeye olanak tanıdı. Kritik hastalardan oluşan bu popülasyonda yüksek komplikasyon oranlarına rağmen sağkalım sonuçları geleneksel tedaviye kıyasla daha olumluydu. CentriMag® sistemi, ileri konjestif kalp yetmezliği ile başvuran akut KŞ hastalarında güvenilir bir karara köprüleme veya transplanta köprüleme seçeneği olarak görünmektedir.

**Anahtar sözcükler:** Kardiyojenik şok; CentriMag; kalp yetersizliği; mekanik dolaşım desteği; ventrikül destek cihazı.

## Introduction

Chronic congestive heart failure (CHF) is an increasingly significant public health problem in both developed and developing countries, contributing to substantial rises in morbidity, mortality, and healthcare expenditures.[1] During episodes of acute decompensation, patients with CHF may experience hemodynamic deterioration, which can progress to cardiogenic shock (CS), a condition characterized by inadequate tissue perfusion.[2] CS is a life-threatening clinical state marked by insufficient cardiac output to meet metabolic demands, resulting in systemic hypoperfusion and multi-organ dysfunction.[3]

Conventionally, acute myocardial infarction (AMI) has been reported as the most common cause of CS. However, recent studies have shown a rising incidence of non-ischemic etiologies, particularly the phenotype referred to as "acute-on-chronic heart failure," which differs from AMI-related CS in its clinical, hemodynamic, and prognostic features.[4–6] Patients in this subgroup often exhibit more pronounced venous congestion, renal dysfunction, and hepatic impairment.[7]

Patients with CHF are monitored according to various clinical classifications. One of the most widely used is the INTERMACS system, which categorizes patients with advanced heart failure into seven profiles based on their clinical severity. The patients evaluated in this study correspond to INTERMACS Profiles 1–2, representing individuals in "critical shock" or in a phase of "progressive decline," who exhibit severe hemodynamic instability. This population carries a high risk of mortality, and timely initiation of short-term mechanical circulatory support (MCS) is of vital importance.[8]

Short-term MCS devices have become an essential therapeutic option for achieving rapid hemodynamic stabilization in patients with advanced CHF presenting with acute CS and for facilitating "bridge-to-decision" or "bridge-to-transplant" strategies.[9,10]

Temporary MCS devices differ substantially in terms of the level of hemodynamic support they provide and their physiological impact. These include intra-aortic balloon pump (IABP), percutaneous ventricular assist devices such as Impella and TandemHeart, venoarterial extracorporeal membrane oxygenation (VA-ECMO), and surgically implanted extracorporeal continuous-flow systems such as the CentriMag®. Each modality offers distinct advantages and limitations, particularly with respect to ventricular unloading, systemic perfusion, and complication profiles.

In recent years, bridging strategies to heart transplantation have shifted markedly toward temporary MCS. According to the 2025 ISHLT Annual Report, the proportion of transplants performed under temporary MCS increased from 11.1% in 2018 to 39.1% in 2024, while transplantation under durable left ventricular assist device (LVAD) support declined substantially.[11] This shift has been partly attributed to changes in donor allocation policies and evolving clinical practices favoring short-term support strategies in critically ill patients.[12]

Nonetheless, the number of studies evaluating short-term central pump systems (such as CentriMag®) specifically in non-ischemic CHF patients remains limited.

The aim of this study was to evaluate the outcomes of short-term central pump support in patients listed for heart transplantation due to chronic CHF who deteriorated to INTERMACS Profiles 1–2 after developing acute CS, and to provide clinical insights for managing this high-risk phenotype.

## Materials and Methods

### Study Design and Patient Population

This study was designed as a single-center, retrospective observational analysis conducted at the Department of Cardiovascular Surgery of our institute. Consecutive patients who underwent implantation of a CentriMag® short-term VAD for CS between September 2010 and December 2013 were included.

This study was approved by the Ethics Committee of Uludag University Faculty of Medicine (Date: 14.10.2014, Approval No: 2014-19/18). This study was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective design, written informed consent was not obtained from patients, and all data were analyzed in an anonymized format.

A total of 30 patients who met the inclusion criteria were identified. CS was defined as persistent hypotension (systolic blood pressure <90 mmHg for ≥30 min or the need for vasopressor support to maintain a mean arterial pressure ≥65 mmHg), clinical signs of end-organ hypoperfusion (oliguria, altered mental status, or elevated serum lactate), and low cardiac output resistant to optimal medical therapy, including inotropic agents and IABP support. Patients who developed shock secondary to AMI were excluded.

Patients in whom the CentriMag® system was used as a bridge-to-decision, bridge-to-recovery, bridge-to-durable support, or bridge-to-transplantation were eligible for inclusion. Patients with incomplete medical records, those supported with alternative extracorporeal systems, or those with contraindications to heart transplantation were excluded from the study.

This study reflects a predefined study period corresponding to a consistent institutional treatment strategy. Following this period, changes in team structure and clinical practice patterns – particularly the adoption of an extracorporeal membrane oxygenation (ECMO)-first strategy in selected patient groups – resulted in a shift away from routine use of CentriMag® support. Therefore, more recent cases were not included in order to maintain cohort homogeneity.

### Device Implantation and Management

The CentriMag® system (Abbott, Abbott Park, IL, USA) is a magnetically levitated, centrifugal, continuous-flow blood pump capable of delivering up to 10 L/min of flow.

The device was implanted via median sternotomy. In one exceptional case, the patient required emergent cardiopulmonary bypass due to pre-operative cardiopulmonary resuscitation for refractory malignant arrhythmias. In all remaining patients, the procedure was performed using direct cannulation without the use of cardiopulmonary bypass.

For left ventricular support, the inflow cannula was inserted into the left atrium through the right superior pulmonary vein, and the outflow cannula was anastomosed to the ascending aorta. Cannulas were externalized through a subxiphoid tunnel, and the chest was closed in the standard fashion.

All patients received isolated left ventricular MCS. Postoperatively, patients were monitored in the intensive care unit with standard hemodynamic surveillance. Anticoagulation therapy was initiated with intravenous unfractionated heparin unless contraindicated, targeting an activated clotting time of 180–200 s. In addition, all patients received daily antiplatelet therapy consisting of acetylsalicylic acid 150 mg and clopidogrel 75 mg.

Because the device is approved for 30 days of support, the pump and circuit tubing were replaced every 30 days while the cannulas were left in place.

### Data Collection and Outcome Measures

Demographic characteristics, baseline clinical findings, laboratory values, and perioperative data were obtained from hospital medical records. Laboratory variables included serum transaminases, creatinine, and blood urea nitrogen levels to assess end-organ dysfunction.

The primary outcomes were survival to hospital discharge and successful bridging to recovery, durable MCS, or heart transplantation. Secondary outcomes included improvement in hemodynamic and laboratory parameters after device implantation, duration of mechanical support, and the incidence of device-related complications (bleeding, infection, thromboembolism, hemolysis, or renal failure).

### Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 15.0 (SPSS Inc., Chicago, IL, USA). The normality of distribution for continuous variables was assessed using visual methods (histograms and probability plots) and analytical tests (Kolmogorov–Smirnov and Shapiro–Wilk tests). Descriptive statistics were presented as frequencies for categorical variables; as mean±standard deviation for normally distributed continuous variables; and as median with interquartile range for non-normally distributed variables.

## Results

A total of 30 patients received short-term MCS with the CentriMag® system. The mean age of the cohort was 32.7±15.2 years (range, 7–60 years), and 21 patients (70%) were male. The mean height was 167.6±14.4 cm, the mean body weight 65.6±17.6 kg, and the mean body mass index 22.8±4.3 kg/m$^2$. Three patients (10%) had a family history of heart failure. None had undergone previous cardiac surgery. Preoperatively, 21 patients (70%) required IABP support. Comorbidities included chronic obstructive pulmonary disease in 4 patients (13.3%), all mild and not contraindicating transplantation, and well-controlled diabetes mellitus in 2 patients (6.6%). Six patients (20%) had a history of hypertension. The mean pre-operative left ventricular ejection fraction was 20.1%±4.0%, and the mean cardiac index was 1.85 L/min/m$^2$ (range, 1.7–2.1) (Table 1).

Regarding etiology, the most common cause of CS was idiopathic dilated cardiomyopathy (n=11, 36.7%), followed by ischemic cardiomyopathy (n=8, 26.7%), myocarditis (n=8, 26.7%), valvular cardiomyopathy (n=1, 3.3%), and peripartum cardiomyopathy (n=2, 6.7%) (Table 2).

Preoperative laboratory values reflected advanced heart failure–related end-organ dysfunction, characterized by elevated serum urea levels (57.4±34.7 mg/dL) and widely variable hepatic enzyme levels.

### Post-Operative Outcomes

Post-operative complications were frequent. Surgical revision due to bleeding was required in 4 patients (13.3%). Arrhythmias occurred in 11 patients (36.6%). Acute kidney injury developed in 12 patients (40%). Prolonged intubation exceeding 72 h was necessary in 3 patients (10%). Two patients (6.6%) developed persistent hypotension despite CentriMag® support and required additional vasopressor therapy. Infectious complications were documented in 10 patients (33.3%) (Table 3).

**Table 1. Baseline demographic and pre-operative clinical characteristics of the patients (n=30)**

| Parameter | Value (mean±SD/n, %) |
|---|---|
| Age (years) | 32.7±15.2 (7–60) |
| Male sex | 21 (70) |
| Height (cm) | 167.6±14.4 |
| Weight (kg) | 65.6±17.6 |
| Body mass index (kg/m$^2$) | 22.8±4.3 |
| Family history of heart failure | 3 (10) |
| Previous cardiac surgery | 0 |
| Comorbidities (total) | 12 (40) |
| Chronic obstructive pulmonary disease | 4 (13.3) |
| Diabetes mellitus (controlled, oral agents) | 2 (6.6) |
| Hypertension | 6 (20) |
| Atrial fibrillation | 8 (26.6) |
| Pre-operative IABP support | 21 (70) |
| LVEF (%) | 20.1±4.0 |
| Cardiac index (L/min/m$^2$) | 1.85 (1.7–2.1) |
| MAP (mmHg) | 57 |
| PVR (Wood units) | 4.1 (2.1–7.6) |
| PCWP (mmHg) | 25 (17–32) |

IABP: Intra-aortic balloon pump; LVEF: Left ventricular ejection fraction; MAP: Mean arterial pressure; PVR: Pulmonary vascular resistance; PCWP: Pulmonary capillary wedge pressure.

**Table 2. Etiology of heart failure**

| Etiology | n (%) |
|---|---|
| Idiopathic | 11 (36.7) |
| Ischemic cardiomyopathy | 8 (26.7) |
| Myocarditis | 8 (26.7) |
| Valvular cardiomyopathy | 1 (3.3) |
| Peripartum cardiomyopathy | 2 (6.7) |
| Total | 30 (100) |

**Table 3. Post-operative outcomes and device-related parameters of the patients (n=30)**

| Parameter | Value (mean±SD/n, %) |
|---|---|
| Surgical revision for bleeding | 4 (13.3) |
| Arrhythmia | 11 (36.6) |
| Acute kidney injury | 12 (40) |
| Prolonged intubation (>72 h) | 3 (10) |
| Infectious complications | 10 (33.3) |
| Persistent postoperative hypotension | 2 (6.6) |
| Duration of CentriMag® support (days) | 33.0 (4–185) |
| Duration of mechanical ventilation (h) | 48.1 (17–210) |
| ICU stay (days) | 38.1 (8–190) |
| Total hospital stay (days) | 92.4 (9–251) |

AKI: Acute kidney injury; ICU: Intensive care unit; SD: Standard deviation.

Laboratory parameters used to assess end-organ dysfunction showed improvement, with serum transaminases demonstrating a downward trend by post-operative day 3. Similarly, serum creatinine levels began to decrease by post-operative day 3 (Table 4).

The mean duration of CentriMag® support was 33.0 days (range, 4–185). Among patients who were successfully bridged to transplantation or durable mechanical support, the mean support duration was 26.1 days (range, 4–58), whereas in those who could not be bridged, the duration was 37.1 days (range, 4–185) (Table 3).

## Clinical Course and Bridging Outcomes

With respect to the bridging strategy, 8 patients (26.7%) were successfully bridged to heart transplantation. In addition, 4 patients (13.3%) were bridged to durable VADs: 3 received the HeartWare® VAD, and one patient received the Berlin Heart® EXCOR device; this latter patient subsequently underwent successful transplantation.

The only patient who underwent CentriMag® implantation under cardiopulmonary resuscitation and cardiopulmonary bypass support has been living in good health for 12 years with HeartWare® device support.

Despite aggressive management, 18 patients (60%) died during hospitalization. The primary causes of death were stroke in 8 patients (26.6%), sepsis in 5 patients (16.6%), respiratory failure due to prolonged mechanical ventilation in 3 patients (10%), and ischemic hepatitis in 2 patients (6.6%) (Table 5).

## Discussion

Although this study reflects an earlier era of MCS, its relevance to contemporary practice lies in the fundamental principles it highlights rather than in device-specific performance. Advances in percutaneous ECMO and short-term ventricular assist systems have reduced procedural invasiveness; however, the challenges of patient selection, timing of support initiation, and achieving effective ventricular unloading in INTERMACS 1–2 CS

**Table 4. Changes in laboratory parameters before and after CentriMag® implantation (n=30)**

| Laboratory parameter | Pre-operative (mean±SD or range) | Post-operative 1 | Post-operative 2 | Post-operative 3 | Post-operative 5 | Post-operative 7 |
|---|---|---|---|---|---|---|
| Blood urea nitrogen (mg/dL) | 57.4±34.7 | 65.7±37.5 | 62.8±37.4 | 65.0±51.9 | 55.6±48.8 | 48.0±40.0 |
| Serum creatinine (mg/dL) | 0.9±0.4 | 1.1±0.7 | 1.1±0.8 | 0.9±0.7 | 0.9±0.8 | 0.7±0.7 |
| AST (U/L) | 415.9 (15–7150) | 489.3 (13–4801) | 644 (18–6578) | 478.5 (19–6672) | 395.3 (8–7532) | 116.3 (9–746) |
| ALT U/L) | 320.4 (6–5573) | 413.7 (5–4194) | 409.8 (5–2892) | 335.9 (4–2251) | 274.5 (2–3410) | 109 (4–810) |

ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; SD: Standard deviation; Pre-operative: Pre-operative day; Post-operative: Post-operative day.

**Table 5. Clinical outcomes and bridging results after CentriMag® implantation (n=30)**

| Outcome | n (%) |
|---|---|
| Bridged to heart transplantation | 8 (26.7) |
| Bridged to durable LVAD (total) | 4 (13.3) |
| HeartWare® Ventricular Assist Device (HVAD®) | 3 (10) |
| Berlin Heart® EXCOR® | 1 (3.3) |
| In-hospital mortality (total) | 18 (60) |
| Primary causes of death | |
| Stroke | 8 (26.6) |
| Sepsis | 5 (16.6) |
| Respiratory failure/prolonged mechanical ventilation | 3 (10) |
| Ischemic hepatitis | 2 (6.6) |

LVAD: Left ventricular assist device, HVAD: HeartWare® ventricular assist device, EXCOR: Berlin Heart® EXCOR®

remain unchanged. The present experience underscores that outcomes in this high-risk population are driven predominantly by disease severity and clinical decision-making strategies, rather than by the specific support platform employed. In this context, the lessons derived from central short-term VAD support continue to inform modern management algorithms within today's expanded MCS armamentarium.

MCS devices used in the treatment of CS have not yet overcome the challenges of high mortality rates and major complications. The most common complications continue to be infection, bleeding, and cerebrovascular events.[13,14] Before the widespread use of MCS systems, the standard therapy consisted of IABP and inotropic support. Although ECMO may be beneficial in selected cases, it does not provide ventricular decompression as effectively as a VAD, and device-related complications are more frequent. Furthermore, the immobility required in ECMO-supported patients constitutes an important disadvantage.[15–17] In contrast, despite its compact and simple design, the CentriMag® device can deliver high flow rates. In our series, as a result of rapid improvement in end-organ function, patients were able to leave the intensive care unit and mobilize within the hospital while on device support. However, as with all extracorporeal systems, limitations such as difficulty with mobilization, short support duration, and risk of thromboembolism persist.

Although ECMO is an effective method of cardiopulmonary support, the increasing risk of complications with prolonged support and the need for anticoagulation remain major limitations. Pagani et al.[15] reported a 1-year survival rate of 43% in patients bridged to LVAD using ECMO. Similarly, Hoefer et al.[14] found a survival rate of 50%, with sepsis-related multiorgan failure being the most common cause of death. In the series by Bayer Erdoğan et al.,[8] early mortality rates of 77% were reported in INTERMACS 1–2 patients supported with ECMO. In our study, the 1-month survival rate among the same high-risk population was 60%, while 40% of patients were successfully bridged to transplantation or durable VAD therapy.

The acute-on-CHF phenotype represented in this study deserves particular consideration. Unlike AMI–related CS, these patients often present with advanced systemic congestion, impaired right ventricular function, and progressive end-organ dysfunction. Delayed referral and prolonged exposure to low cardiac output states may further worsen prognosis. In this context, early initiation of effective MCS capable of providing sufficient ventricular unloading may be particularly important in improving outcomes in this subgroup.

CentriMag® is a versatile pump that can be used for various purposes and, despite requiring sternotomy, is relatively easy to implant. In a multicenter study by Joyce et al.,[18] the device was shown to provide adequate ventricular decompression for right, left, or biventricular support. Reported survival rates were 47% in the overall cohort, 50% in CS following myocardial infarction, and 58% in right ventricular failure after LVAD implantation. In our study, CentriMag® was used exclusively for left ventricular support, and the rate of successful bridging to transplantation or durable VAD therapy was 40%. The main advantages of CentriMag® include ease of implantation, effective ventricular unloading, and reliable pump performance. However, survival rates in this patient population remain relatively low, largely reflecting the severity of illness rather than device-related factors.

Recent European experience further supports the role of CentriMag® as a bridge-to-transplant strategy. A multicenter study from Spain, including 358 patients over a 10-year period, demonstrated the feasibility of surgically implanted extracorporeal continuous-flow systems in bridging to heart transplantation.[19] Similarly, a single-center experience from the United Kingdom reported over 100 patients supported with temporary CentriMag® biventricular assistance over more than a decade, highlighting its durability and effectiveness in advanced heart failure patients.[20]

These findings suggest that, in contrast to contemporary United States practice – where IABP, ECMO, and percutaneous devices predominate – European centers may utilize surgically implanted short-term systems more frequently in transplant-listed patients.

Among short-term mechanical support systems, devices such as ABIOMED BVS® (ABIOMED Inc., Danvers, MA) and Bio-Medicus® (Medtronic) are also available, with ECMO and percutaneous systems serving as alternatives in selected cases. Samuel et al.[21] reported a hospital discharge rate of 31% with the ABIOMED BVS, although drawbacks include the need for aortic and pulmonary anastomoses, increased bleeding risk, and weekly device replacement.[22,23]

More recent data on CentriMag® use have shown encouraging outcomes.[24–26] In addition to single- or biventricular support, the device can provide full cardiopulmonary support when combined with an oxygenator. Russo et al.[27] used CentriMag® as VA-ECMO and reported an 80% success rate. John et al.[25] found a 30-day survival rate of 75% in patients supported for isolated left ventricular failure. In our cohort, the 30-day survival – considering patients bridged to LVAD or transplantation – was 60%. Haj-Yahia et al.[28] reported successful transplantation in all four patients who received biventricular CentriMag® support after

an average of 87 days. The long potential duration of support, flexibility in cannulation strategies, and straightforward management are important advantages of the CentriMag® system. De Robertis et al.[26] reported more than 80% 1-month survival and a mean support duration of 47 days in patients supported for "bridge-to-decision." In our study, the mean duration of support was 26 days, with a maximum duration of 59 days among patients bridged to transplantation. In cases where long-term support is anticipated, initiating therapy with CentriMag® using cannulas compatible with durable VADs is a reasonable strategy.[29,30]

The Thoratec paracorporeal VAD systems also belong to the short-term support category. Multicenter studies have reported a transplantation bridging success rate of 70% and a recovery rate of 67% after postcardiotomy shock.[31] The variability in survival rates across studies can be attributed to differences in patient selection and clinical characteristics. Although Joyce et al.[18] demonstrated comparable survival between CentriMag® and older-generation devices, CentriMag® may offer advantages in selected cases. Percutaneous systems such as TandemHeart® and Impella® may also be alternatives in appropriately selected patients.[32–34] However, their limitations – including lower achievable flow rates, lack of right ventricular support, and difficulties with mobilization – restrict their use. Despite requiring surgical implantation, CentriMag® remains a more effective option for bridging to decision, transplantation, or durable VAD therapy.

The literature on short-term VADs underscores the need for additional data to determine the optimal support system. Single-center studies are inherently limited by differences in patient selection and treatment protocols. Without randomized controlled trials, it remains challenging to eliminate selection bias and develop definitive treatment strategies.

### Limitations

This study has several limitations. First, its retrospective, single-center design and small sample size limit the generalizability of the findings. Second, the absence of a contemporary control group prevents direct comparison with alternative support modalities. Third, long-term follow-up data after hospital discharge were not available for all patients, limiting the comprehensive evaluation of outcomes following transplantation or durable LVAD implantation. Finally, advancements in device technology and perioperative management strategies since the study period may restrict the applicability of these results to current clinical practice.

## Conclusion

In summary, the CentriMag® short-term VAD provided effective circulatory support in patients with refractory CS and enabled meaningful recovery or successful bridging in a substantial proportion of cases. Despite the inherently high complication rates expected in this critically ill population, the survival outcomes were better than those anticipated with conventional treatment strategies. Our findings support the use of the CentriMag® system as a valuable bridge-to-decision option in patients with advanced heart failure presenting with CS.

### Disclosures

**Ethics Committee Approval:** The study was approved by the Uludag University Faculty of Medicine Ethics Committee (no: 2014-19/18, date: 14/10/2014).

**Informed Consent:** Due to the retrospective nature of the study, informed consent was waived by the Ethics Committee.

**Conflict of Interest Statement:** None declared.

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## References

1. Savarese G, Lund LH. Global Public Health Burden of Heart Failure. Card Fail Rev 2017;3:7–11.
2. Metra M, Teerlink JR. Heart failure. Lancet 2017;390:1981–95.
3. van Diepen S, Katz JN, Albert NM, Henry TD, Jacobs AK, Kapur NK, et al. Contemporary management of cardiogenic shock: A scientific statement from the American Heart Association. Circulation 2017;136:e232–68.
4. Baran DA, Grines CL, Bailey S, Burkhoff D, Hall SA, Henry TD, et al. SCAI clinical expert consensus statement on the classification of cardiogenic shock. Catheter Cardiovasc Interv 2019;94:29–37.
5. Olarte N, Rivera NT, Grazette L. Evolving presentation of cardiogenic shock: A review of the medical literature and current practices. Cardiol Ther 2022;11:369–84.
6. Sinha SS, Rosner CM, Tehrani BN, Maini A, Truesdell AG, Lee SB, et al. Cardiogenic shock from heart failure versus acute myocardial infarction: Clinical characteristics, hospital course, and 1-year outcomes. Circ Heart Fail 2022;15:e009279.
7. Bertaina M, Morici N, Frea S, Garatti L, Briani M, Sorini C, et al. Differences between cardiogenic shock related to acute decompensated heart failure and acute myocardial infarction. ESC Heart Fail 2023;10:3472–82.
8. Bayer Erdoğan S, Baştopçu OM, Acarel M, Er H. Analysis of clinical results for decision making for short- and long-term ventricular support in INTERMACS I and II patients. GKDA Derg 2022;28:295–9.
9. Burkhoff D, Naidu SS. The science behind percutaneous mechanical circulatory support. J Am Coll Cardiol 2018;72:298–308.
10. Den Uil CA, Akin S, Jewbali LS, Dos Reis Miranda D, Brugts JJ, Constantinescu AA, et al. Short-term mechanical circulatory support as a bridge to durable left ventricular assist device implantation in refractory cardiogenic shock: A systematic review and meta-analysis. Eur J Cardiothorac Surg 2017;52:14–25.
11. Singh TP, Hsich E, Cherikh WS, Perch M, Hayes D Jr, Lewis A, et al. The international thoracic organ transplant registry of the international society for heart and lung transplantation: 2025 annual report of heart and lung transplantation. J Heart Lung Transplant 2025;44:1857–73.
12. Kumar A, Alam A, Flattery E, Dorsey M, Yongue C, Massie A, Patel S, Reyentovich A, Moazami N, Smith D. Bridge to transplantation: policies impact practices. Ann Thorac Surg 2024;118:552–63.
13. Kherani AR, Cheema FH, Oz MC, Fal JM, Morgan JA, Topkara VK, et al. Implantation of a left ventricular assist device and the hub-and-spoke system in treating cardiogenic shock: Who survives? J Thorac Cardiovasc Surg 2003;126:1634–5.
14. Hoefer D, Ruttmann E, Poelzl G, Kilo J, Hoermann C, Margreiter R, et al. Outcome evaluation of the bridge-to-bridge concept in patients with cardiogenic shock. Ann Thorac Surg 2006;82:28–33.

15. Pagani FD, Lynch W, Swaniker F, Dyke DB, Bartlett R, Koelling T, et al. Extracorporeal life support to left ventricular assist device bridge to heart transplant: A strategy to optimize survival and resource utilization. Circulation 1999;100:II206-10.
16. Pagani FD, Aaronson KD, Swaniker F, Bartlett RH. The use of extracorporeal life support in adult patients with primary cardiac failure as a bridge to implantable left ventricular assist device. Ann Thorac Surg 2001;71:77–81.
17. Smedira NG, Moazami N, Golding CM, McCarthy PM, Apperson-Hansen C, Blackstone EH, et al. Clinical experience with 202 adults receiving extracorporeal membrane oxygenation for cardiac failure: survival at five years. J Thorac Cardiovasc Surg 2001;122:92–102.
18. John R, Long JW, Massey HT, Griffith BP, Sun BC, Tector AJ, et al. Outcomes of a multicenter trial of the Levitronix CentriMag ventricular assist system for short-term circulatory support. J Thorac Cardiovasc Surg 2011;141:932–9.
19. Cabezón-Villalba G, Barge-Caballero E, González-Vílchez F, Castel-Lavilla MÁ, Gómez-Bueno M, Almenar-Bonet L, et al. Use of a surgically implanted, nondischargeable, extracorporeal continuous flow circulatory support system as a bridge to heart transplant. Rev Esp Cardiol (Engl Ed) 2024;77:39–49.
20. Aurovid S, Aziz ZA, Shafi A, Poon S, Wang L, Das De S, et al. Temporary Centrimag BiVAD support as a bridge to heart transplantation: the last decade of experience at Royal Papworth Hospital. J Heart Lung Transplant 2024;43(4 Suppl):S279.
21. Samuels LE, Holmes EC, Thomas MP, Entwistle JC, Morris RJ, Narula J, Wechsler AS. Management of acute cardiac failure with mechanical assist: experience with the ABIOMED BVS 5000. Ann Thorac Surg 2001;71(3 Suppl):S67–72; discussion S82–5.
22. Morgan JA, Stewart AS, Lee BJ, Oz MC, Naka Y. Role of the Abiomed BVS 5000 device for short-term support and bridge to transplantation. ASAIO J. 2004;50:360–3.
23. Marelli D, Laks H, Fazio D, Hamilton MA, Fonarow GC, Meehan DA, et al. Mechanical assist strategy using the BVS 5000i for patients with heart failure. Ann Thorac Surg 2000;70:59–66.
24. De Robertis F, Birks EJ, Rogers P, Dreyfus G, Pepper JR, Khaghani A. Clinical performance with the Levitronix Centrimag short-term ventricular assist device. J Heart Lung Transplant 2006;25:181–6.
25. John R, Liao K, Lietz K, Kamdar F, Colvin-Adams M, Boyle A, et al. Experience with the levitronix centrimag circulatory support system as a bridge to decision in patients with refractory acute cardiogenic shock and multisystem organ failure. J Thorac Cardiovasc Surg 2007;134:351–8.
26. De Robertis F, Rogers P, Amrani M, Petrou M, Pepper JR, Bahrami T, et al. Bridge to decision using the Levitronix CentriMag short-term ventricular assist device. J Heart Lung Transplant 2008;27:474–8.
27. Russo CF, Cannata A, Lanfranconi M, Bruschi G, Milazzo F, Paino R, et al. Veno-arterial extracorporeal membrane oxygenation using Levitronix centrifugal pump as bridge to decision for refractory cardiogenic shock. J Thorac Cardiovasc Surg 2010;140:1416–21.
28. Haj-Yahia S, Birks EJ, Amrani M, Petrou M, Bahrami T, Dreyfus G, et al. Bridging patients after salvage from bridge to decision directly to transplant by means of prolonged support with the CentriMag short-term centrifugal pump. J Thorac Cardiovasc Surg 2009;138:227–30.
29. Maat AP, van Thiel RJ, Dalinghaus M, Bogers AJ. Connecting the centrimag levitronix pump to Berlin heart excor cannulae; a new approach to bridge to bridge. J Heart Lung Transplant 2008;27:112–5.
30. Loforte A, Potapov E, Krabatsch T, Musci M, Weng Y, Pasic M, et al. Levitronix CentriMag to Berlin Heart Excor: a "bridge to bridge" solution in refractory cardiogenic shock. ASAIO J 2009;55:465–8.
31. Slaughter MS, Tsui SS, El-Banayosy A, Sun BC, Kormos RL, Mueller DK, et al. Results of a multicenter clinical trial with the thoratec implantable ventricular assist device. J Thorac Cardiovasc Surg 2007;133:1573–80.
32. Kar B, Adkins LE, Civitello AB, Loyalka P, Palanichamy N, Gemmato CJ, et al. Clinical experience with the TandemHeart percutaneous ventricular assist device. Tex Heart Inst J 2006;33:111–5.
33. Gregoric ID, Jacob LP, La Francesca S, Bruckner BA, Cohn WE, Loyalka P, et al. The TandemHeart as a bridge to a long-term axial-flow left ventricular assist device (bridge to bridge). Tex Heart Inst J 2008;35:125–9.
34. Siegenthaler MP, Brehm K, Strecker T, Hanke T, Nötzold A, Olschewski M, et al. The Impella Recover microaxial left ventricular assist device reduces mortality for postcardiotomy failure: a three-center experience. J Thorac Cardiovasc Surg 2004;127:812–22.