Use of durable mechanical circulatory support on outcomes of heart–kidney transplantation†

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Abstract

OBJECTIVES: Previous studies have demonstrated that preheart transplant mechanical circulatory support (MCS) can lead to a small but significant increase in mortality. However, data on outcomes of patients with MCS who require simultaneous heart–kidney transplant are limited.

METHODS: A retrospective review of simultaneous heart–kidney transplantsations (HKTxs) performed at a single institution over a 5-year period was performed. Patients were divided based on the preoperative use of durable MCS. Renal graft-related end points were evaluated, including glomerular filtration rate following transplantation, prevalence of delayed renal graft function and freedom from antibody and cellular-mediated graft rejection. Patient-specific outcomes, including survival and frequency of non-fatal major adverse cardiac events at 1 year, were additionally assessed.

RESULTS: During the study period, 50 HKTxs were performed, 14 of which had preoperative MCS. HKTx patients with and without MCS implantations had a similar prevalence of delayed graft function (57.1% vs 50.0%; P = 0.757). A numerical trend was observed towards a reduced glomerular filtration rate 1-month post-transplant in patients without an MCS device (81.2 ± 32.8 vs 64.4 ± 27.5; P = 0.072), but no significant difference was observed at 6 and 12 months. No significant difference was observed on the need for post-transplant renal replacement therapy, non-fatal major adverse cardiac events, freedom from graft rejection and overall survival at 1 year.

CONCLUSIONS: The use of preoperative MCS in patients undergoing combined HKTx was not found to affect renal graft function post-transplantation and does not seem to be associated with increase in morbidity or mortality.

Keywords: Heart transplantation • Kidney transplantation • Mechanical circulatory support

INTRODUCTION

It has been well established that the presence of chronic renal disease prior to heart transplantation is associated with increased morbidity and mortality and was previously considered a contraindication to heart transplant candidacy [1, 2]. The presence of renal insufficiency with heart failure is not an uncommon association; more than 30% of heart transplant recipients have an estimated glomerular filtration rate (GFR) of less than 45 ml/min [3]. With advancements in surgical technique, perioperative management and immunosuppression, it has since been shown that simultaneous heart–kidney transplantation (HKTx) can be performed successfully in patients with end-stage failures of both organs with survival equivalent to isolated heart transplant recipients [4–6]. This technique was first described by Norman et al. [7] in 1978, and the number of HKTx has steadily grown. Since 2000, the annual frequency of these simultaneous transplants performed in the USA has increased over 2-fold [2, 8].

Concurrently, mechanical circulatory support (MCS) has demonstrated to play a critical role as a bridge to transplantation option in patients with end-stage heart failure [9–11]. The rapid evolution of heart failure management using MCS is additionally reflected by remarkable and frequent innovations in device technologies [12–14]. With newer continuous-flow MCS devices becoming ever more prevalent, and with current increase in the number of HKTx being performed, the determination of the potential impact of pretransplant MCS implantation on outcomes is essential. Unfortunately, the literature evaluating outcomes in MCS patients receiving HKTx remains limited. In this study, we sought to evaluate outcomes of HKTx recipients using preoperative MCS in the contemporary era performed at a single, high-volume transplant institution.
MATERIALS AND METHODS

All simultaneous adult orthotopic heart–kidney transplants performed at a single tertiary care institution from 2010 to 2015 were retrospectively evaluated. Patients were divided based on the preoperative use of durable MCS. Durable MCS was defined as the use of a left ventricular assist device, a biventricular assist device or a total artificial heart. Indications for MCS implantation followed standard criteria and included patients with severe and progressively decompensating heart failure without contraindications (e.g. active infection, ongoing bleeding and high risk for non-compliance) to therapy. The institutional electronic medical record was used to query variables. Preoperative demographics, such as medical history, was assessed.

The primary outcome assessed included renal function, which was described in terms of GFR up to 12 months (1, 6 and 12 months post-transplantation), the prevalence of delayed graft function (the need for dialysis within 7 days post-transplantation) and the need for chronic (≥1 month) renal replacement therapy. Additionally, 1-year survival and 1-year graft outcomes were evaluated. Graft outcomes were evaluated based on incidence of any treated rejection, acute cellular rejection and antibody-mediated rejection. Secondary patient outcomes were additionally assessed based on freedom from cardiac allograft vasculopathy and freedom from non-fatal major adverse cardiac events (NF-MACE: myocardial infarction, new congestive heart failure, percutaneous coronary intervention or angioplasty, implantable cardioverter-defibrillator or pacemaker implant and stroke) at 1 year.

Institutional review board approval was attained, and informed consent was obtained. Continuous variables are expressed as a median with interquartile range (IQR) or mean and standard deviation, whereas categorical variables are expressed as a percentage. Continuous variables were compared using the Student’s t-test, and categorical variables were analysed using the Fisher’s exact test. The Kaplan–Meier curve analysis was used to display patient survival and freedom from chronic renal replacement therapy. Statistical analysis was performed using the SAS Software, Version 9.2 (Statistical Analysis System Institute, Cary, NC, USA).

RESULTS

During the 5-year study period, 50 simultaneous HKTxs were performed, with 14 (28%) receiving a pretransplant MCS. Demographics between HKTx + MCS and HKTx-only patients, as listed in Table 1, were similar with regard to age, body mass index and gender. Evaluation of medical comorbidities such as diabetes, hyperlipidaemia and peripheral vascular disease were not statistically different between cohorts.

Transplant-related factors (Table 2) revealed that a significantly greater proportion of HKTx + MCS were United Network for Organ Sharing (UNOS) status 1 when compared with HKTx-alone patients (100.0% vs 66.7%; P = 0.012). Furthermore, all HKTx + MCS patients were reoperative cardiac surgery patients compared with 55.6% of patients in the HKTx group (P = 0.002). The frequency of ≥2 sternotomies was also significantly increased in HKTx + MCS patients. As noted in the detailed profile of mechanical device support, the majority were in place for >90 days (92.9%): 64.3% comprised total artificial heart devices, 21.4% biventricular assist device and 14.3% left ventricular assist device.

Table 1: Patient demographics

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient age (years)</td>
<td>54.4 ± 6.8</td>
<td>58.2 ± 11.0</td>
<td>0.235</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>25.3 ± 6.0</td>
<td>24.7 ± 5.0</td>
<td>0.720</td>
</tr>
<tr>
<td>Female</td>
<td>14.3</td>
<td>25.0</td>
<td>0.705</td>
</tr>
<tr>
<td>Prior pregnancy</td>
<td>100.0</td>
<td>75.0</td>
<td>1.000</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>71.4</td>
<td>55.6</td>
<td>0.353</td>
</tr>
<tr>
<td>African American</td>
<td>14.3</td>
<td>16.7</td>
<td>1.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>14.3</td>
<td>13.9</td>
<td>1.000</td>
</tr>
<tr>
<td>Other</td>
<td>0.0</td>
<td>13.9</td>
<td>0.304</td>
</tr>
<tr>
<td>Medical history</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>50.0</td>
<td>69.4</td>
<td>0.325</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>42.9</td>
<td>36.1</td>
<td>1.000</td>
</tr>
<tr>
<td>Hypertension</td>
<td>66.7</td>
<td>58.3</td>
<td>1.000</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>28.6</td>
<td>30.5</td>
<td>1.000</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>28.6</td>
<td>11.1</td>
<td>0.197</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>14.3</td>
<td>16.7</td>
<td>1.000</td>
</tr>
<tr>
<td>Stroke</td>
<td>7.1</td>
<td>5.6</td>
<td>1.000</td>
</tr>
<tr>
<td>COPD</td>
<td>50.0</td>
<td>27.8</td>
<td>0.187</td>
</tr>
</tbody>
</table>

Values are presented as a mean ± standard deviation or percentage. COPD: chronic obstructive pulmonary disease; HKTx: heart–kidney transplantation; MCS: mechanical circulatory support.

Table 2: Pretransplant factors

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNOS status 1 at transplant</td>
<td>100.0</td>
<td>66.7</td>
<td>0.012</td>
</tr>
<tr>
<td>Cytomegalovirus mismatch</td>
<td>21.4</td>
<td>33.3</td>
<td>0.507</td>
</tr>
<tr>
<td>Prior blood transfusion</td>
<td>92.9</td>
<td>62.5</td>
<td>0.072</td>
</tr>
<tr>
<td>Pretransplant PRA &gt; 10%</td>
<td>28.6</td>
<td>27.8</td>
<td>1.000</td>
</tr>
<tr>
<td>MCS support length</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-term support (&lt;90 days)</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-term support (&gt;90 days)</td>
<td>92.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MCS device type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVAD</td>
<td>14.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BiVAD</td>
<td>21.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAH</td>
<td>64.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior interventions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous cardiac surgery</td>
<td>100.0</td>
<td>55.6</td>
<td>0.002</td>
</tr>
<tr>
<td>≥2 sternotomies</td>
<td>64.3</td>
<td>11.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>14.3</td>
<td>12.4</td>
<td>1.000</td>
</tr>
<tr>
<td>Prior PCI</td>
<td>42.9</td>
<td>50.0</td>
<td>0.757</td>
</tr>
</tbody>
</table>

Values are presented as a percentage.
BiVAD: biventricular assist device; CABG: coronary artery bypass grafting; HKTx: heart–kidney transplantation; LVAD: left ventricular assist device; MCS: mechanical circulatory support; PCI: percutaneous coronary intervention; PRA: panel reactive antibody; TAH: total artificial heart; UNOS: United network for organ sharing.

Table 3 displays a preoperative medication use. Treatment prevalence with various antihypertensives, aspirin or clopidogrel was not significantly different between cohorts.

Table 4 presents perioperative characteristics of both groups. Both cardiopulmonary bypass [166.5 (IQR 48.0) min vs 153.0 (IQR 41.0) min; P = 0.007] and total operative time [623.0 (IQR 96.5) min vs 479.0 (IQR 106.0) min; P = 0.029] were greater in HKTx + MCS cases, as were perioperative blood product requirements [30.0 (IQR 10.9) units vs 19.1 (IQR 8.6) units; P < 0.001].
Postoperatively, however, no significant difference was demonstrated in reoperative interventions for bleeding. The need for temporary supplemental MCS (extracorporeal membrane oxygenation or intra-aortic balloon pump), intubation times or overall hospital length-of-stay seemed to be similar.

Baseline GFR in both groups (Table 5) was not statistically different (mean 19.2 ± 7.2 ml/min vs 22.5 ± 17.4 ml/min; P = 0.497). A notable trend towards reduced GFR was observed in non-MCS HKTx patients at 1-month post-transplantation (mean 81.2 ± 32.8 ml/min vs 64.4 ± 27.5 ml/min; P = 0.072), although no significant differences were identified at 6 and 12 months. HKTx recipients with and without MCS implantations demonstrated a similar prevalence of delayed graft function (57.1% vs 50.0%; P = 0.757). Although percentage of patients requiring haemodialysis was similar, median duration of haemodialysis support was significantly greater in HKTx without prior MCS [5.0 (IQR 1.0) days vs 9.0 (IQR 12.5) days; P = 0.035].

Table 6 lists outcomes at 1-year post-transplantation. The incidence of any treated rejection, acute cellular rejection and antibody-mediated rejection was not significantly different. Similarly, the rate of cardiac allograft vasculopathy (0% vs 3.7%; P = 0.505) and NF-MACE (7.1% vs 5.6%; P = 0.868) between the 2 groups was similar. The Kaplan–Meier analysis of freedom from chronic dialysis requirement (Fig. 1) was comparable between cohorts at 1 year (85.7% vs 94.4%; P = 0.306). Additionally, evaluation of 1-year survival between groups (Fig. 2) revealed no statistically significant differences in mortality rates between prior MCS and no MCS use after HKTx (100% vs 94%; P = 0.365).

**DISCUSSION**

Cardiac transplantation has long been established as the standard treatment for patients with end-stage heart disease [15]. A growing number of those with heart failure have been identified to have additional multiorgan dysfunction. The adverse outcomes of patients with renal insufficiency undergoing isolated cardiac transplantation are well documented [6, 16]. Multiple studies, including analysis of the UNOS registry database, have demonstrated improved survival in those receiving HKTx when compared with isolated heart transplantation OHT in heart failure patients with concurrent non-dialysis and dialysis-dependent renal insufficiency, leading to an increasing number

**Table 3:** Preoperative medication profile

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-blockers</td>
<td>53.8</td>
<td>66.7</td>
<td>0.508</td>
</tr>
<tr>
<td>Nitrates</td>
<td>57.1</td>
<td>61.1</td>
<td>1.000</td>
</tr>
<tr>
<td>ACE inhibitors</td>
<td>44.4</td>
<td>38.9</td>
<td>1.000</td>
</tr>
<tr>
<td>Angiotensin II receptor blockers</td>
<td>15.4</td>
<td>30.6</td>
<td>0.293</td>
</tr>
<tr>
<td>Calcium channel blockers</td>
<td>35.7</td>
<td>13.9</td>
<td>0.118</td>
</tr>
<tr>
<td>Phosphodiesterase inhibitors</td>
<td>21.4</td>
<td>11.1</td>
<td>0.384</td>
</tr>
<tr>
<td>Midodrine</td>
<td>57.1</td>
<td>37.1</td>
<td>0.222</td>
</tr>
<tr>
<td>Aspirin</td>
<td>92.9</td>
<td>100.0</td>
<td>0.280</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>38.5</td>
<td>29.4</td>
<td>0.728</td>
</tr>
</tbody>
</table>

Values are presented as a percentage.

ACE: angiotensin converting enzyme; HKTx: heart–kidney transplantation; MCS: mechanical circulatory support.

**Table 4:** Peritransplant characteristics

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPB duration (min)</td>
<td>166.5 (48.0)</td>
<td>153.0 (41.0)</td>
<td>0.007</td>
</tr>
<tr>
<td>Total operative time (min)</td>
<td>623.0 (96.5)</td>
<td>479.0 (106.0)</td>
<td>0.029</td>
</tr>
<tr>
<td>Total blood products (units)</td>
<td>30.0 (10.9)</td>
<td>19.1 (8.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reoperation for bleeding</td>
<td>0.0</td>
<td>5.6</td>
<td>1.000</td>
</tr>
<tr>
<td>Postoperative circulatory support</td>
<td>0.0</td>
<td>0.0</td>
<td>1.000</td>
</tr>
<tr>
<td>IABP</td>
<td>7.1</td>
<td>2.8</td>
<td>0.486</td>
</tr>
<tr>
<td>ECMO</td>
<td>12.1</td>
<td>36.1</td>
<td>0.122</td>
</tr>
<tr>
<td>Mechanical ventilation time (h)</td>
<td>68.0 (44.7)</td>
<td>58.1 (10.0)</td>
<td>0.464</td>
</tr>
<tr>
<td>ICU length of stay (days)</td>
<td>8.0 (2.0)</td>
<td>6.0 (3.0)</td>
<td>0.122</td>
</tr>
<tr>
<td>Total hospital length of stay (days)</td>
<td>15.0 (10.0)</td>
<td>15.5 (10.0)</td>
<td>0.916</td>
</tr>
</tbody>
</table>

Values are presented as a median (interquartile range) or percentage.

CPB: cardiopulmonary bypass; ECMO: extracorporeal membrane oxygenation; HKTx: heart–kidney transplantation; IABP: intra-aortic balloon pump; ICU: intensive care unit; MCS: mechanical circulatory support.

**Table 5:** Pretransplant and post-transplant renal function

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFR (ml/min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretransplant</td>
<td>19.2 ± 7.2</td>
<td>22.5 ± 17.4</td>
<td>0.497</td>
</tr>
<tr>
<td>1-Month post-transplant</td>
<td>81.2 ± 32.8</td>
<td>64.4 ± 27.5</td>
<td>0.072</td>
</tr>
<tr>
<td>6-Month post-transplant</td>
<td>66.6 ± 32.2</td>
<td>74.8 ± 29.1</td>
<td>0.447</td>
</tr>
<tr>
<td>12-Month post-transplant</td>
<td>72.3 ± 26.3</td>
<td>61.9 ± 21.2</td>
<td>0.235</td>
</tr>
<tr>
<td>Delayed graft function</td>
<td>57.1</td>
<td>50.0</td>
<td>0.757</td>
</tr>
<tr>
<td>Haemodialysis</td>
<td>42.9</td>
<td>38.9</td>
<td>1.000</td>
</tr>
<tr>
<td>Haemodialysis duration (days)</td>
<td>5.0 (1.0)</td>
<td>9.0 (12.5)</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Values are presented as mean ± standard deviation, median (interquartile range) or percentage.

GFR: glomerular filtration rate; HKTx: heart–kidney transplantation; MCS: mechanical circulatory support.

**Table 6:** Survival, allograft rejection and complication rates

<table>
<thead>
<tr>
<th></th>
<th>HKTx + MCS (n = 14)</th>
<th>HKTx (n = 36)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Months</td>
<td>100.0</td>
<td>97.2</td>
<td>0.533</td>
</tr>
<tr>
<td>1 Year</td>
<td>100.0</td>
<td>94.0</td>
<td>0.365</td>
</tr>
<tr>
<td>1-Year freedom from any treated infection</td>
<td>23.1</td>
<td>22.2</td>
<td>0.747</td>
</tr>
<tr>
<td>1-Year freedom from CAV</td>
<td>100.0</td>
<td>96.3</td>
<td>0.505</td>
</tr>
<tr>
<td>1-Year freedom from NF-MACE</td>
<td>92.9</td>
<td>94.4</td>
<td>0.868</td>
</tr>
<tr>
<td>Heart transplant rejection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Year freedom from ATR</td>
<td>92.9</td>
<td>88.4</td>
<td>0.651</td>
</tr>
<tr>
<td>1 Year freedom from ACR</td>
<td>100.0</td>
<td>94.1</td>
<td>0.360</td>
</tr>
<tr>
<td>1 Year freedom from AMR</td>
<td>100.0</td>
<td>94.3</td>
<td>0.368</td>
</tr>
<tr>
<td>1 Year freedom from BNR</td>
<td>92.9</td>
<td>100.0</td>
<td>0.114</td>
</tr>
</tbody>
</table>

Values are presented as a percentage.

ACR: acute cellular rejection; AMR: antibody-mediated rejection; ATR: any-treated rejection; BNR: biopsy negative rejection; CAV: cardiac allograft vasculopathy; HKTx: heart–kidney transplantation; MCS: mechanical circulatory support; NF-MACE: non-fatal major adverse cardiac event.
of HKTx performed in the past decade [2, 6, 8, 17, 18]. In addition to the changing paradigms of multiorgan transplantation, the introduction and rapid growth of MCS devices have led to a transformation in the overall management of heart failure and are being increasingly used in cardiac transplant programmes as bridging therapy [19–21]. This question is particularly relevant in the context of continued concerns over appropriate and optimal resource allocation due to persistent donor allograft shortages [2]. The haemodynamic advantage of ventricular unloading with continuous flow MCS prior to isolated cardiac transplantation has been demonstrated to improve post-transplant survival [19]. Despite this benefit, some authors have raised concerns regarding the use of MCS prior to transplantation. Using the UNOS database, Patolla et al. [22, 23] found a small but significant increase in risk (hazard ratio 1:2) at 6 months post-transplantation for those receiving intracorporeal VADs, although this hazard ratio was reduced to 1:1 at 4-year follow-up.

The literature on the impact of preoperative MCS in the context of HKTx remains limited and conflicting. In a small case series, Yanagida et al. [24] reported excellent outcomes supporting the use of MCS as a viable option prior to HKTx. A UNOS registry-based analysis noted that the survival of HKTx patients with prior MCS was equivalent to that of non-MCS HKTx [17]. However, Russo et al. [3] found that ventricular assist device was an independent risk factor and was associated with increased mortality attributed to increased risk of infection. A major notable consideration for these aforementioned studies is that they partly or completely comprised early MCS experiences where the use of pulsatile devices was predominant, prior to the landmark HeartMate II trial in 2009 demonstrating the benefits of continuous-flow VADs [25].

This study makes several unique observations. Over a 5-year contemporary period, patients with prior MCS implementation accounted for over a quarter of all HKTx performed at our institution and suggests that this clinical association may be even more common as MCS therapy becomes increasingly prevalent. In our experience, HKTx + MCS and HKTx-only patients seemed to have similar preoperative demographics, transplant risk factors and medication use. We did identify an increase in both cardiopulmonary bypass support and total operative duration, which was likely attributed to the requisite time spent on removing the MCS device prior to orthotopic transplantation. Despite the increased procedural time and total number of blood products transfused, no increase was observed in in-hospital morbidity, including reoperative interventions for bleeding, the need for postoperative circulatory support and intubation duration or prolonged length of stay.

Of additional interest was that median haemodialysis duration was greater in the HKTx-only cohort, despite having statistically similar rates of haemodialysis requirement frequency and incidence of delayed graft function. A numerical trend was observed in increased GFR in the MCS group immediately post-transplantation. Although this did not reach statistical significance and was not sustained, it potentially supports the concept of device pretransplantation optimization of intravascular haemodynamics. Nevertheless, based on overall GFR and the frequency of chronic dialysis postoperatively, the use of MCS devices did not seem to be deleterious to renal allograft function. Patient outcomes over 12-month post-transplantation, including freedom from NF-MACE, heart transplant rejection and survival, was not statistically different between both groups. These findings potentially demonstrate that combined HKTx in patients with MCS is reasonable as no significant increase is observed in morbidity or mortality. This seems to be in contradistinction to reports of decreased survival in MCS patients following isolated cardiac transplantation. The burden of low cardiac output in end-stage heart failure and the resulting reduction in organ perfusion have been known to precipitate renal dysfunction [4]. There may be a subset

Figure 1: One-year freedom from chronic dialysis using the Kaplan–Meier analysis. HKTx: heart–kidney transplantation; MCS: mechanical circulatory support.

Figure 2: One-year survival using the Kaplan–Meier analysis. HKTx: heart–kidney transplantation; MCS: mechanical circulatory support.
of patients undergoing isolated heart transplantation with underlying, undiagnosed renal dysfunction, thereby affecting mortality rates. Furthermore, many of these initial considerations of MCS’s negative impact on isolated cardiac transplantation outcomes were primarily based on pulsatile devices and, therefore, may not correlate to the newest MCS generation [21].

Limitations

We acknowledge several limitations of this study. We appreciate the challenges inherent in a single-institution retrospective study. The small sample size also impacted the power of this study; simultaneous HTKxs are a relatively infrequently performed procedure, and, therefore, obtaining larger sample sizes is intrinsically difficult. Pooled assessment of HTKxs performed at multiple centres may provide improved statistical power while adjusting for potential geographical or institutional-specific variables. Follow-up over the past 1-year endpoint will additionally be of interest for longer-term outcome analyses. Despite these limitations, this study provides a preliminary evaluation of MCS prior to HTKx in the contemporary era. These results encourage further evaluation but seem to suggest that HTKx is a viable treatment option in patients with MCS as a bridge to transplantation with concomitant renal insufficiency.

Conflict of interest: none declared.

REFERENCES