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A Review: Using Hypothermic Storage System to Improve Heart Transplant Outcomes

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Abstract

During organ transport, a novel technology known as the Cardiac Transport System provides stable and optimal hypothermic control. The purpose of this study was to compare the results of using the system with those of using the conventional static cold storage method after a heart transplant. 62 and 186 patients underwent primary heart transplantation at Stanford University from 2018 to June 2021, with follow-up through May. All-cause mortality was the primary end point, and postoperative complications were the secondary end points. Kaplan-Meier survival analyses, optimal variable ratio matching, and the cox proportional hazards regression model were used [1]. The matched patients were older and had received organs with significantly longer total allograft ischemic times prior to matching. After matching, patients required fewer units of blood product for perioperative transfusion than patients, but their postoperative outcomes—hospital length of stay, primary graft dysfunction, inotrope score, use of mechanical circulatory support, cerebral vascular accident, myocardial infarction, respiratory failure, new renal failure necessitating dialysis, postoperative bleeding reoperation, infection, and survival—were comparable [2].

In conclusion, this is one of the very first retrospective comparison studies to examine the outcomes of heart transplantation with preserved and system-transported organs [3]. Even though the total allograft ischemic time was long, the good results may justify implementing a system that accepts organs from faraway locations to broaden the donor pool.

Keywords: Hypothermic; Retrospective; Cellular immunity; Heart Transplantation

Introduction

One of the most common donor heart preservation techniques involves storing the organ submerged in the University of Wisconsin cold organ preservation solution2 and then bagged to be placed in a cooler filled with slush ice. This has been the standard method of organ preservation worldwide for decades. However, the entire organ is not evenly cooled by this conventional SCS organ preservation method. In point of fact, an animal study demonstrated that when the SCS technique was utilized, parts of the myocardium were placed in direct contact with ice, which resulted in a suboptimal storage temperature of 2 °C [4]. This caused protein denaturation and decreased function following the transplant3. At the present time, a lack of donor organs is one of the main obstacles that prevent heart transplantation from being used to treat patients with end-stage heart failure. Although the SCS technique allows for some time for organ transportation from the donors to the recipients, when prolonged, it can lead to cold ischemic injury, resulting in reduced graft function and patient survival.13 Increased total ischemic time has also been shown to be associated with higher mortality after heart transplantation [5].14 The Food and Drug Administration–cleared Cardiac Transport System (Paragonix Technologies, Braintree, MA) is a novel technology that provides stable, optimal hypothermic control during organ transport The purpose of this study was to compare early outcomes following heart transplantation using this novel technology versus the SCS method for organ preservation and transportation and to describe our experience with this temperature-controlled hypothermic storage system.

Methods

At our centre, a new method for preserving organs was implemented in July 2020. 122 patients at Stanford University received donor hearts that were preserved and transported for primary heart transplantation between July 2020 and May 2022; 62 of these people had heart transplants performed on them between July 2020 and June 2021. The inclusion of these 62 patients in the final cohort allowed for at least one year of follow-up for analysis. The inclusion period was extended from January 2018 to June 2021 to include 186 patients in the final cohort in order to include an adequate number of patients for appropriate matching. Multiorgan transplantation beneficiaries, aside from the people who got heart-lung transplantation, were remembered for this review. Patients who had heart transplants were not included in the cohort. Both prospective data collection and a retrospective review of the patients' charts were used to complete the data collection. All-cause mortality was the primary end point, and postoperative complications were the secondary end points.

To create similar associates of patients concerning preoperative comorbidities and to relieve bewildering factors, the ideal variable proportion matching procedure was adopted.18 The ideal variable proportion matching enjoys the benefit of further developing equilibrium in covariates between the 2 gatherings, lessening clear predispositions from 1:1 or fixed proportion matching while at the same time utilizing accessible information. Preoperative use of mechanical circulatory support (MCS) devices like extracorporeal membrane oxygenation, intra-aortic balloon pumps, and ventricular assist devices, in addition to multiorgan transplantation, served as the basis for exact matching. Then, a nonparsimonious strategic

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relapse model was utilized for patients to adjust the preoperative qualities between the 2 gatherings [6]. The recipient's age, sex, height, and body mass index were the variables used to calculate the propensity score; donor gender, age, and BMI; beneficiary preoperative comorbidities (hypertension, diabetes, coronary corridor sickness, implantable cardioverter-defibrillator, hospitalization status, earlier sternotomy); recipient's hemoglobin, platelet, creatinine, and alanine aminotransferase levels before surgery; and the total ischemic time of the allograft. Penchant scores of 2 gatherings were matched by factor proportions of 1:1 to 1:3. The minimal global propensity score distance was obtained by matching two patients on average to one patient using this algorithm. The standardized mean difference and variance ratio of all variables used to calculate the propensity score were evaluated to determine balance following matching. An acceptable balance between the two groups is indicated by a variance ratio between 0.5 and 2 and an absolute standardized mean difference of less than 0.25 [7].

Patients' outcomes might be better with donor organ preservation and transportation at the optimal temperature, according to the hypothesis. With temperatures controlled between 4 °C and 8 °C, high-energy phosphate can be better preserved, likely contributing to excellent good posttransplant graft function22. However, in this study, we did not find any significant differences in postoperative graft function, need for MCS support, or survival both before and after matching. Extremely low temperatures with direct contact with ice, as is frequently observed using SCS, may introduce frostbite injury.15 Our efforts to use organs from marginal donors have helped maximize organ allocation and reduce waitlist time without deteriorating patient outcomes.10 With the advancement of organ preservation technologies like the system, we were armed with additional tools to allow us to further expand our donor pool by accepting marginal donors for select recipients from a more distant location without deteriorating patient outcomes.1,6,23 With over five decades of experience in heart transplantation, we have significantly improved donor selection and matching.1,6,23 Specifically, our efforts toward using In this review, we showed that patients, for the greater part of the result measures, performed in basically the same manner to patients subsequent to coordinating. In addition, we discovered that fewer units of blood product were required for perioperative transfusion in patients. It has been recently shown that drawn out cardiopulmonary detour time is related with deteriorated coagulopathy.25,26 Curiously, we noticed no genuinely tremendous contrast in cardiopulmonary detour time between the 2 gatherings in this review, albeit the typical detour time was more limited in the versus the companion [8]. In addition, after matching, the average level of alanine aminotransferase in the cohort was within normal range, but it was significantly higher than that in the cohort. These patients with gentle liver brokenness probably gave coagulopathy, which perhaps added to a more serious requirement for blood items preoperatively. In patients undergoing heart transplantation, increased perioperative blood transfusion was independently associated with major adverse events27,28. The significant finding that the system reduced blood product requirements may also have contributed to the excellent outcomes observed in this study.

Results

The outcomes of the two groups were compared using optimal variable ratio matching. Even though the total allograft ischemic time was within an acceptable range in terms of variable balance after matching, there was still a significant difference, with patients receiving organs with a longer total allograft ischemic time overall. However, despite this significant difference, both groups had similar immediate postoperative outcomes and 1-year survival rates, a system that precisely regulates temperature, may have prevented allograft damage or dysfunction during the prolonged ischemic period, allowing for successful heart transplantation without additional risks. The Cox proportional hazards regression model was utilized in order to adjust for the variation in total allograft ischemic time. Compared to SCS, the use of results in a 45 percent reduction in morality risk after transplantation, even though the hazard ratio for survival was not significantly higher. In a curious finding, we also discovered that when SCS was used, the total allograft ischemic time was significantly increased with a risk of death. For every 10 minutes of longer total allograft ischemic time, a risk of death was significantly increased by 11%. However, when the was utilized, the total allograft ischemic time had no significant effect on mortality; however, it did show a trend of an increase in the mortality risk of 4.5 percent for each ten minutes that the total allograft ischemic time was prolonged. However, it is difficult to determine from this one-institution database whether the nonsignificant finding was caused by a small effect or a small sample size. The total allograft ischemic time using the in this study was significantly longer than what was previously reported.15-17 This is an important finding, which could potentially support our expanding practice by accepting donor organs from a more geographically distant location. However, we hypothesized that the improved organ preservation and transportation system using further dampened the negative effect of prolonged total allograft ischemic time.24 Despite the shorter preparation time, the system is more expensive than SCS, with an estimated total cost of $16,000. The management is uncomplicated; In addition, it is still less expensive than other preservation systems, like the TransMedics Organ Care System.15,29 In addition, it has been hypothesized that may reduce the overall cost of post-transplantation hospital care compared to SCS due to possibly better outcomes.

Conclusion

This is one of the first retrospective comparison studies that evaluated the outcomes of heart transplantation using organs preserved and transported using the system compared with SCS. Although the group showed longer total allograft ischemic time, patients using required fewer units of blood product for perioperative transfusion and had similar early-term survival compared with SCS. Although a multicenter trial is warranted to further validate findings described in this study, accepting organs from a more remote location may be a safe and practical strategy to expand the donor pool by using advanced technologies, such as the system.

Acknowledgement

None

Conflict of Interest

None

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