

Cardiac Surgery Outcomes in Abdominal Solid Organ Transplant Recipients

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Background. Cardiovascular disease is a cause of morbidity and mortality in organ transplant recipients. Cardiac surgery after organ transplantation is not uncommon in this population. We evaluated 30-day outcomes and long-term survival of abdominal transplant recipients undergoing cardiac surgery at our institution.

Methods. In all, 138 patients with previous kidney, kidney-pancreas, and liver transplants underwent cardiac surgery from 2000 to 2016. Propensity score (ratio 1:3) matched 115 abdominal transplant with 345 patients undergoing cardiac surgery without a history of abdominal transplant. They were matched for type and year of cardiac surgery, age, sex, body mass index, history of diabetes mellitus, and creatinine level before cardiac surgery.

Results. Median time from abdominal transplant to cardiac surgery was 7 years (interquartile range, 3 to 12 years). Perioperative variables, including surgery and cardiopulmonary bypass time, aortic cross-clamp and intubation time, and intensive care unit stay did not

differ between the groups. Hospital length of stay and rate of 30-day hospital readmissions did not differ between the groups. Patients with abdominal transplants had more strokes (4% versus 0.6%; $p = 0.005$) within 30 days after surgery. There were no differences in renal failure, bleeding, site infections, atrial fibrillation, and pneumonia between the groups. Five patients (4%) died within 30 days after surgery in the abdominal transplant group (4 kidneys, 1 liver, 0 kidney-pancreas), and 7 patients (2%) died in the nontransplanted group ($p = 0.24$).

Conclusions. Previous history of abdominal transplant is associated with an increased 30-day incidence of stroke after cardiac surgery. Abdominal transplant does not affect 30-day mortality after cardiac surgery, whereas long-term survival is significantly reduced. Regular patient follow-up and prevention and early treatment of postoperative complications are key to patient survival.

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In 2016 alone, 17,333 kidney, 732 kidney-pancreas, and 1,127 liver transplants were performed in the United States [1]. Improvements in surgical techniques, organ preservation, perioperative care, and postsurgical therapy including immunosuppression therapy have contributed to better outcomes and overall survival for patients undergoing abdominal organ transplants [2, 3]. However, many abdominal transplant recipients have a number of comorbidities and are exposed to cardiovascular risk factors [4]. In addition, chronic immunosuppression therapy after transplant may cause or accelerate cardiovascular diseases, necessitating surgical intervention [5–7]. Studies have shown that after a cardiac operation, mortality among patients with end-stage renal disease and renal transplant is substantially higher than

among patients with normal renal function [8, 9]. Many liver transplant patients also have cardiac events after transplant [10]. Cardiac surgical procedures in these patients may be challenging, however, and risky owing to an increased risk of infection secondary to immunosuppression and the potential impact of cardiac surgery on the functional capacity of the transplanted organ.

A number of studies exist on abdominal solid organ transplants and various types of cardiac operations [11–14]. They report excellent results of cardiac surgery in patients with functioning abdominal transplants [10, 14–17]. However, very few studies report long-term results of cardiac surgery or include a control group in the analysis. Here, we investigated the 30-day morbidity and mortality and long-term survival of patients undergoing cardiac surgery after abdominal solid organ

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transplant at our institution. Results were compared with matched nontransplant patients.

Patients and Methods

We retrospectively analyzed 6,330 consecutive patients undergoing cardiac surgery at our institution between January 2000 and December 2016. Through our institutional transplant database, we identified 138 patients with previous kidney, kidney-pancreas, and liver transplants. These patients received immunosuppression therapy until the time of cardiac surgery. Steroids were the most common immunosuppressive agent. All patients who were extubated received maintenance doses of the immunosuppressive regimen, the day after operation. Cyclosporine or tacrolimus were held, discontinued, or decreased in patients whose renal function worsened after cardiac surgery. The transplant medicine team closely followed up all transplant patients after cardiac surgery.

Propensity score matching [18] was used to identify patients undergoing cardiac surgery without a history of abdominal transplant. They were matched for type of cardiac surgery, year of cardiac surgery, age at cardiac surgery, sex, body mass index at cardiac surgery, history of diabetes mellitus, and pre-cardiac surgery serum creatinine. Multivariate logistic regression was used to generate the propensity score, and then a greedy algorithm was used to perform the 1:3 match: a set of X cases is matched to a set of Y cases in a set of X decisions. Once a match is made, the match is not reconsidered. That match is the best match currently available. The algorithm makes “best” matches first and “next-best” matches next, in a hierarchical sequence until no more matches can be made. Best matches are those with the highest digit match on propensity score. First, cases are matched to nontransplant cases on 8 digits of the propensity score. For those that do not match, cases are then matched to nontransplant cases on 7 digits of the propensity score. The algorithm proceeds sequentially to the lowest digit match on propensity score (1 digit). This is referred to as the “8→1 digit match.”

In addition, transplant patients were compared with the entire patient cohort undergoing cardiac surgery without a history of abdominal transplant ($n = 6,192$). Our Institutional Review Board approved this study and a waiver of consent was obtained. Data were prospectively acquired and maintained in our Institutional Review Board-approved database. The long-term survival was obtained through our institution's yearly follow-up electronic database. All transplanted patients had complete long-term survival follow-up. Ninety percent of the matched group used for comparison had complete long-term survival follow-up; the other 10% were checked against the Social Security Death Index.

Statistical Analysis

Continuous variables are represented as mean $\pm$ SD, and categorical variables are represented as number and percentage. When the distribution appeared to be skewed, we produced median and interquartile range (IQR) and

compared using the Mann-Whitney U test. Continuous variables were compared using Student's t test and one-way analysis of variance. Categorical variables are presented as number and percentage and were compared using the χ^2 test.

The Kaplan-Meier survival method was used to assess postcardiac surgery survival. Log rank tests were used to assess statistical significance in survival differences between the groups. Multivariable analysis was used to examine whether prior organ transplant is an independent risk factor of 30-day mortality. Cox regression was used to determine whether a history of prior abdominal organ transplant had an effect on patient survival. All p values less than 0.05 (two-sided) were considered statistically significant. All analyses were performed using IBM SPSS Statistics 21 software program (IBM Corporation, Armonk, NY).

Results

One hundred-thirty-eight patients with functioning kidney, kidney-pancreas, and liver transplants underwent cardiac surgery between 2000 and 2016. Propensity score (ratio of 1:3) matched 115 of them with 345 patients undergoing cardiac surgery without a history of solid organ transplant, used for comparison.

Mean age at transplant was 50 ± 12 years, and mean age at time of heart surgery was 58 ± 11 years (Table 1). Males comprised the majority of the patient population ($n = 88$; 76%). Mean patient body mass index was 28 ± 6 kg/m², with 34% ($n = 39$) being obese (body mass index ≥ 30 kg/m²). Most patients had a history of hypertension ($n = 108$; 93%) or diabetes mellitus ($n = 71$; 61%). Moderate or severe left ventricular dysfunction with an ejection fraction less than 35% was present in 11 patients (9%). Thirty-nine patients (34%) had a history of myocardial infarction, 35 (30%) had a history of peripheral vascular disease, and 19 (16%) had a history of cerebrovascular accidents. Mean preoperative creatinine level was 2.2 ± 1.5 mg/dL. Median time from transplant to cardiac surgery was 7 years (IQR: 3 to 12). (For a more detailed patient preoperative clinical history based on type of abdominal transplant, refer to Supplemental Table 1. For a detailed patient demographic history including the entire cohort of patients having cardiac surgery, refer to Supplemental Table 2).

Cardiac procedures performed in these patients included coronary artery bypass graft surgery (CABG [$n = 56$; 48%]), valve repair or replacement ($n = 37$; 32%), CABG and valve ($n = 14$; 12%), and other ($n = 9$; 8%). Approximately one fourth ($n = 32$; 28%) of cardiac surgeries were urgent cases, and 5% ($n = 6$) were emergent procedures. Cardiopulmonary bypass was utilized in 90 patients (78%). Median bypass time was 137 minutes (IQR: 107 to 176), and median cross-clamp time was 93 minutes (IQR: 73 to 125). Bypass and aortic cross-clamp time of transplanted patients was not different when compared with their matched patients (Table 2) or with the entire cohort of patients having cardiac surgery (Supplemental Table 3). Hospital length of stay and time

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