

A 25 Year Review of Combined Cardiac and Renal Transplant Outcomes in Patients with End Stage Cardiac Failure on Renal Replacement Therapy. A Single Center Experience

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Citation: Anthony, C., et al. A 25 Year Review of Combined Cardiac and Renal Transplant Outcomes in Patients with End Stage Cardiac Failure on Renal Replacement Therapy. A Single Center Experience. (2016) J Heart Cardiol 2(2): 59-67.

Received Date: February 08, 2016; Accepted Date: July 12, 2016; Published Date: July 15, 2016

Abstract

Background: Combined heart and kidney transplantation has been shown to be a viable option for patients who have concurrent end stage cardiac and renal failure. However there is limited long term survival data that compares the outcomes of patients undergoing combined heart-kidney transplantation to patients undergoing solitary cardiac transplantation. There is also limited data on patients with end stage cardiac failure who are on concurrent renal replacement therapy prior to organ transplantation and their outcomes. This study reviews the short and long term outcomes of combined heart kidney transplantation over a 25 year period in comparison to solitary cardiac transplantation in a majority of patients undergoing renal replacement therapy at time of transplant listing.

Methods and Results: In total there were 16 patients who underwent combined heart and kidney transplantation in the period between October 1990 and June 2014 (including heart and kidney re-transplantation) with 14 patients (87.5%) on renal replacement therapy at time of combined procedure. They were listed for combined heart and kidney transplantation as they fulfilled our institution's criteria for irreversible end-stage heart and kidney failure. Retrospective review of patient data from the transplant database, patient case notes and post-mortem reports were carried out. Statistical analysis was then performed on key patient demographics alongside actuarial survival analysis, which were then graphically annotated. IRB approval was obtained and informed consent from patients was also obtained.

The mean (SD) recipient age was 42 (13) years and there were 3 females. Dilated cardiomyopathy was the most common primary cardiac pathology (50%) whilst ischemic nephrosclerosis (25%) and glomerulonephritis (25%) were the most common primary renal pathologies. Most patients experienced NYHA class IV symptoms (62.5%). The average wait time to transplantation at our institution was 12 months.

There was no operative mortality. The cumulative 1 year survival in the combined transplant group was 0.75 with 4 out of 16 mortalities within the first year (25%). In comparison the cumulative 1 year survival of the heart only transplant group was 0.86 with 116 mortalities within the first year over a 25 year period.

Cumulative survival at 5, 10, 15 and 25 years for the combined transplant group was 0.69, 0.55, 0.437 and 0.437 respectively. In comparison cumulative survival of the heart only transplant group at the 5, 10, 15 and 25 year mark was 0.76, 0.59, 0.45 and 0.23 respectively.

The incidence of cardiac rejection episodes in the study time was 9 out of 16 (56%) versus 3/16 (19%) who had renal rejection. In the study period there was 1 death out of 7 deaths due to dual graft failure.

Conclusions: Combined sequential cardiac and renal transplantation has good short- and long-term outcomes for patients with co-existing end stage cardiac and renal failure. At the ten year mark actuarial survival for combined heart and kidney transplantation is equivalent to cardiac transplantation alone.

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Keywords: Combined Heart Kidney Transplant; Heart Failure; Renal Failure; Cardiorenal Syndrome

Introduction

Chronic kidney disease in the context of cardiac transplantation is a significant contributor to increased morbidity and mortality^[1,2]. In addition there is established evidence that between 30 - 40% of patients admitted to hospital with heart failure have concurrent renal impairment^[3,4] with significantly worse morbidity and mortality outcomes^[3,5-10]. Since the initial report of simultaneous heart-kidney transplantation in 1978, combined solid-organ transplantation has evolved into a viable option for patients with end stage cardiac and renal failure^[11-35]. This is especially important in the context of patients with end stage cardiac failure who are on renal replacement therapy, where solitary cardiac transplant alone may be contraindicated. We report our experience with 16 patients over a 25 year period 14 of whom were on concurrent renal replacement therapy which we believe is the longest retrospective review of patients to have undergone simultaneous combined heart and kidney transplantation and compared their outcomes to the outcomes of patients undergoing solitary heart transplantation at our institution.

Methods

A retrospective observational study was undertaken. During the period between October 1990 and June 2014, a total of 16 patients underwent combined heart and kidney transplantation at our institution. In the period between Feb 1984 and May 2014 a total of 866 patients underwent orthotopic heart transplantation at our institution.

A retrospective review of medical, surgical and intensive care records and the transplant database was completed on these 16 patients. The records were reviewed for patient demographics, co-morbidities, etiology of cardiac and renal failure, baseline cardiac and renal function, renal replacement requirement and duration of renal replacement prior to transplant, right heart study pre transplant, time on the transplant waiting list, peri-transplant acute and long term complications, rejection events, graft function and long term mortality outcomes. These results were documented and tabulated and patients numbered accordingly 1-16 in all tables (Table 1- 4). Data was summarized using means ± standard deviation for numeric variables and percents and counts for categorical variables. (Table 1,2)

Table 1: Patient Characteristics Pre Transplantation

Patient	Age	Sex	Co-morbidities	Etiology of Renal Dysfunction	Kidney function Creatinine mmol/l	Duration of Renal Replacement Therapy Prior to Transplant or Post Transplantation Months	Etiology of Cardiac Dysfunction	EF	ECMO/LVAD prior to Tx	Right Heart Catheter -Pulmonary Artery pressure mmHg
1	61	M	HPT, Dyslipidemia	Post Infection GN, Ischemic nephrosclerosis	280	1 month HD post Tx	RF/Valvular CM+ IHD	20%	IABP	50
2	23	F	Wilms Tumors, CKD, Aniridia	WAGR syndrome- Bilateral Wilms Tumors- Right nephrectomy Left partial nephrectomy: c1q GN in remaining kidney	Haemodialysis	60 months pre transplant	Anthracycline induced cardiomyopathy.	10%	IABP	45
3	52	M	Hypertension, Dyslipidemia, Anemia, Secondary Hyperparathyroidism	Ischemic nephrosclerosis +/-cardiorenal syndrome	Haemodialysis	96 months pre transplant	DCM	15%	IABP	40
4	27	M	DCM	Chronic Allograft nephropathy (Multiple Heart and Kidney Transplantation)	Continuous Ambulatory Peritoneal Dialysis	12 months pre transplant	Allograft Vasculopathy (Multiple Heart and Kidney Transplantation)	25%	Nil	32

5	43	M	CKD, HPT, Dyslipidemia	MCGN type 1	Haemodialysis	36 months pre transplant	Viral myocarditis	20%	Nil	13
6	45	M	CKD, HPT, Dyslipidemia	Post Strep GN 1st kidney tx	Haemodialysis	24 months pre transplant	IHD/Valvular CM/CABG 86	15%	Nil	40
7	52	M	HPT,CKD	IGA nephropathy	Haemodialysis	14 months pre transplant	DCM	20%	Nil	45
8	39	M	DCM	Calcineurin inhibitor toxicity +/- Cardiorenal Syndrome	Continuous Ambulatory Peritoneal Dialysis	3 months pre transplant	DCM+ allograft vasculopathy 2 nd heart	15%	ECMO to TX	47
9	53	M	Polycystic Kidney Disease	Polycystic Kidney Disease	180	Nil	DCM	30%	Nil	42
10	53	M	CKD/DCM	Reflux nephropathy	Haemodialysis	84 months pre transplant	DCM	23%	Nil	27
11	32	M	IGA nephropathy/CKD, Gout, Dyslipidemia	IGA nephropathy	Continuous Ambulatory Peritoneal Dialysis	36 months pre transplant	DCM	19%	Nil	30
12	58	M	IHD/ Anterior MI leading to Cardiac Arrest, CKD	Ischemic-nephrosclerosis + Sepsis related Acute Kidney Injury	Continuous Ambulatory Peritoneal Dialysis	3 months CAPD + 1 month HD	IHD	20%	Nil	46
13	37	F	CKD/ IGA nephropathy	IGA Nephropathy	Continuous Ambulatory Peritoneal Dialysis + transitioned to Haemodialysis	36 months CAPD + 12 month HD	Peripartum cardiomyopathy	15%	ECMO post Tx	28
14	43	F	SLE	Lupus Nephritis	Haemodialysis	60 months (Multiple renal transplantation)	IHD	28%	Nil	34
15	16	M	CKD,IHD	Obstructive Uropathy	Haemodialysis	CAPD 12 months + HD 9 months	DCM	10%	Nil	38
16	54	M	Chronic AF, Hypertension, Dyslipidemia PVD,Osteoporosis	Ischemic Nephrosclerosis +/- Cardiorenal Syndrome	Continuous Ambulatory Peritoneal Dialysis	12 months	DCM	18%	Nil	30

DCM: Dilated Cardiomyopathy. AF: Atrial Fibrillation. MI: Myocardial Infarct. CKD: Chronic Kidney Disease. CAPD: Continuous Ambulatory Peritoneal Dialysis. HD: Haemodialysis. MCG: Mesangiocapillary Glomerulonephritis. WAGR: Wilms Tumors, Aniridia, Genitourinary Abnormality, Mental Retardation syndrome. RF: Rheumatic Fever. ECMO: Extracorporeal Membrane Oxygenation. IABP: Intraortic Balloon Pump. Tx: Transplant, Strep: Streptococcal

Table 2: Patient Characteristics Pre Transplant

Patient characteristics Pre-Transplant	Mean ± SD	Range	Percentage%
Age at transplantation (y)	42.875 ± 13.0	16 - 61	
Male sex (13/16)			81
Dilated Cardiomyopathy (8/16)			50
Ischemic Cardiomyopathy 3 (18.75%)			18.75
NYHA class III (6/16)			37.5
NYHA class IV (10/16)			62.5
IABP/ECMO Peri- Transplant (5/16)			31.3
LVEF (%)	18.9 ± 5.7		
Mean Pulmonary Artery Pressure (mmHg)	36.7 ± 9.7	13 - 50	

Ischemic Nephrosclerosis/ Cardiorenal Syndrome (4/16)			25
Glomerulonephritis (4/16)			25
Iga Nephropathy (3/16)			18.7
Creatinine level (mmol/L)		390 ± 179.2	
RRT prior to Transplantation (14/16)			87.5
Time on RRT prior to transplant (months)		36.4 ± 29.5	
Wait time to transplant (months)		12..2 ± 7.1	

The patient selection criteria include all patients with New York Heart Association class III and IV cardiac failure as per the International Society for Heart and Lung Transplant (ISHLT) indications for cardiac transplantation. The patients must have had concomitant renal failure with creatinine clearances of less than 30 mL/min and/or required renal replacement therapy at time of consideration for cardiac transplantation.

HLA typing was not done preoperatively on all patients and was omitted for the patients that did have them performed. The hearts were procured by the cardiac transplantation service at our institution, and the kidneys by the surgical team designated by the organ procurement coordinator. The heart transplant was performed first on table followed by kidney transplantation in all 16 cases.

Immunosuppressive therapy was documented and tabulated and changes to their regimen in the 25 year follow up period were documented. Endomyocardial biopsies were performed according to our institutions protocol or when cardiac rejection was suspected the grading was documented and tabulated (Table 3) as per the ISHLT classification. Only the most significant episode of rejection was documented. Renal rejection was confirmed with renal biopsies when clinically and biochemically suspected and rejection episodes tabulated (Table 3).

Table 3: Acute Complications Post Transplant and Episodes of Rejection with Immunosuppressive Regimen

Patient	Acute complications	Cardiac rejection	Renal Rejection	Immunosuppression Post Transplant	Current immunosuppression
1	Sepsis from sternal wound infection- Resulting in Acute Renal failure	3A rejection. Pulsed methylpred	Nil	Cyclosporine 100 mg bd Mycophenolate 500 mg bd Prednisone 10 mg daily	Cyclosporine 100 mg bd Mycophenolate 500 mg bd Prednisone 10 mg daily
2	Sepsis VRE, Pericardial Effusion	Nil	Yes	Cyclosporine 125 mg bd, Mycophenolate 1g BD, Prednisone 10 mg	Tacrolimus 4 mg tds, Sirolimus 1 mg tds, Mycophenolate, 1.5 g bd, Prednisone 25 mg daily
3	Cardiac Arrest- Resuscitated , ARF- HD, Leakage from bladder anastomosis, Herpes Simplex infection	3A rejection. Pulsed methylpred	Nil	Cyclosporine 150 mgbd Mycophenolate 1 g bd Pred 15 mg bd	Tacrolimus 2 mg bd Mycophenolate 1 g bd Prednisone 15 mg bd
4	Stroke post transplant	Nil	Nil	Cyclosporine 100 mg bd Azathioprine 150 mg daily Prednisone 25 mg daily	Tacrolimus 2 mg bd Everolimus 0.75 mg bd Mycophenolate 500 mg bd Prednisone 2.5 mg daily
5	Nil Significant	Nil	Nil	Cyclosporin 150 mg bd Azathioprine 100 mg daily Prednisone 12.5 daily	Cyclosporin 100 mg daily Everolimus 0.75 mg bd Prednisone 5mg daily
6	Cardiac Arrest off bypass. Resuscitated successfully	1a rejection	Nil	Cyclosporin 250mg bd Azathioprine 125 mg daily Prednisone 25 mg daily	cyclosporin 100 mg bd, Azathioprine 75 mg daily prednisone 10 mg faily
7	Nil Significant	Nil	Nil	Cyclosporin 25 mg Bd Everolimus 0.5 mg mane Mycophenolate 1 gbd Prednisone 5 mg daily	Cyclosporin 25 mg Bd Everolimus 0.5 mg mane Mycophenolate 1 gbd Prednisone 5 mg daily
8	VA ecmo post tx-Respiratory Failure- re intubated, sepsis (lung),ATN requiring CV-VHDF-HD post tx ,DIC, Ischemic hepatitis, GI bleeding	Nil	Nil	Cyclosporin 150 mg bd Azathioprine 100 mg daily Prednisone 12.5 daily	Cyclosporin 100/75 Mycophenolate 1.5 g BD Prednisolone 10 mg daily
9	Nil Significant	3A rejection. Methylprednisone	Nil	Cyclosporine 100 mg bd Azathioprine 150 mg daily Prednisone 10 mg	Cyclosporin 75/50 Mycophenolate 1 g bd Pred 3 mg daily
10	Ureteric leak- HD post op	Mild 1a rejection	Nil	Cyclosporine 100 mg bd Azathioprine 150 mg daily Prednisone 10 mg	Cyclosporin 75/50 Mycophenolate 1g bd Pred 3 mg daily

11	Nil Significant	Mild	Nil	Cyclosporin 100/75 Azathioprine 150 mg daily, Prednisolone 10 mg daily	Cyclosporin 100/75 Mycophenolate 1.5 g BD Prednisolone 10 mg daily
12	Renal Biopsy hemorrhage-laparotomy. CVVHDF, pseudobstruction	Nil	Nil	Cyclosporin 125 mg bd Mycophenolate 1g Bd Prednisolone 15 mg daily	Cyclosporin 50 mg bd Mycophenolate 1 gbd Sirolimus 1 mg daily
13	Cardiogenic shock, Pneumothorax	3a Rejection. Plasmapheresis+ methylprednisone	Yes	Cyclosporine 125 mg bd Azathioprine 150 mg daily prednisolone 50 mg daily	Tacrolimus 5 mg bd, Azathioprine 100 mg daily, Prednisone 7 mg daily
14	Sepsis, hypotension	3b rejection	Nil	Cyclosporine 150 mg bd Azathioprine 100 mg daily Prednisone 12.5 mg daily	Cyclosporin 100/75 Mycophenolate 1.5g BD Prednisolone 10 mg daily
15	Nil Significant	3b rejection	Yes	Cyclosporine 150 mg bd Azathioprine 125 mg daily Prednisolone 25 mg daily	Tacrolimus 5 mg daily Azathioprine 150 mg daily Mycophenolate 500 mg bd Prednisone 15 mg daily,
16	Respiratory Failure- re intubated, sepsis (lung), ATN requiring CVVHDF-HD post tx 1/12	3a Rejection	Nil	Cyclosporine 150 mg bd Mycophenolate 1.5 gm bd Prednisone 25 mg daily	Cyclosporin 100 mg daily Everolimus 0.75/0.25 Mycophenolate 2g bd Prednisone 2.5 mg daily

Cumulative survival outcomes were calculated with the actuarial method of estimation. The actuarial survival was calculated for the combined heart and kidney transplant group, the cardiac transplant only group with a subsequent comparison over a 25 year follow up period. These results were graphically analysed and compare

Results

Pre-transplant characteristics

Patient demographic and clinical characteristics are indicated in Table 1. The mean and standard deviations of preoperative characteristics are indicated in Table 2. The mean age of the recipients was 42.9 with a range of 16 - 61. The majority of recipients were of Caucasian decent however there were 2 of Asian descent and 2 of Mediterranean descent. Thirteen of the recipients were male and three were female. 50% of the recipients had dilated cardiomyopathy as their primary cardiac pathology whilst ischemic nephrosclerosis or glomerulonephritis encompassed the majority of primary renal pathology at 50%. Five patients or 33% required ECMO or IABP prior to combine transplantation. The mean preoperative ejection fraction was 18.9 percent with a range of 10 - 30 percent. The mean pulmonary arterial pressure was 36.7 mmHg with a range of 13 - 50. Three patients were recipients of multiple organ transplantation and 1 of these patients was a recipient of sequential heart and kidney transplant followed by combined heart kidney transplant due to allograft failure.

Postoperative outcomes

There was no operative mortality in all 16 cases. The acute complications post transplant along with their initial immunosuppressant regimens are listed in Table 3. Their initial immunosuppressant regimen and their subsequent changes are also listed in Table 3.

One patient died within the first month of combined heart transplantation from multisystem organ dysfunction and sepsis. Sepsis from a respiratory source was the most common post operative complication with 31% of patients having a documented episode of significant respiratory sepsis. Two of these patients required re-intubation to support their respiratory function. Five patients or 31% required a period of renal replacement therapy post operatively. All except 1 patient was transitioned off renal replacement within the first 6 months post transplant.

There were 7 patients or 43% who had significant cardiac rejection with 2 patients experiencing mild cardiac rejection as per the ISHLT classification. Three or 19% of patients had documented renal rejection. Two of these patients did have a preceding significant episode cardiac rejection with only one patient having and isolated episode of renal rejection.

Renal graft function remained stable throughout the study period in 14 out of 16 patients or 87.5%. 11 out of 16 patients had stable cardiac function post combined transplant throughout the study period or 69% of the cohort.

Chronic allograft vasculopathy was the most common major complication in the study period with 25% of patients experiencing reduced cardiac function as a consequence.

The actuarial 1 year survival in the combined transplant group was 75% with 4 out of 16 dying within the first year (25%). In comparison the actuarial survival of the heart only transplant group was 86% accounting for 116 deaths within the first year of the 866 patients in this group over a 25 year period.

Actuarial survival at 5, 10, 15 and 25 years for the combined transplant group was 69%, 55%, 43.7% and 43.7% respectively. (Figure 1)

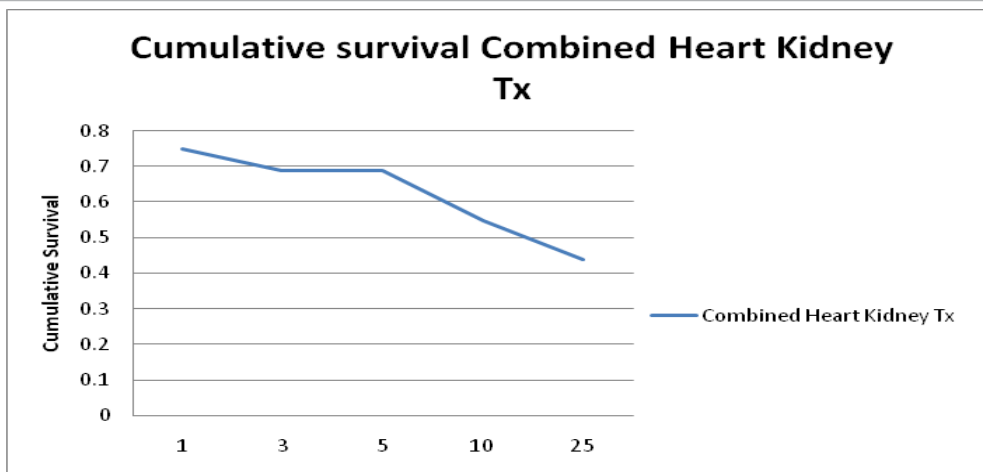


Figure 1: Cumulative Survival of Combined Heart Kidney Transplant over 25 years.

In comparison cumulative survival of the heart only transplant group at the 5, 10, 15, and 25 year mark was 76%, 59%, 45%, and 23% respectively. (Figure 2)

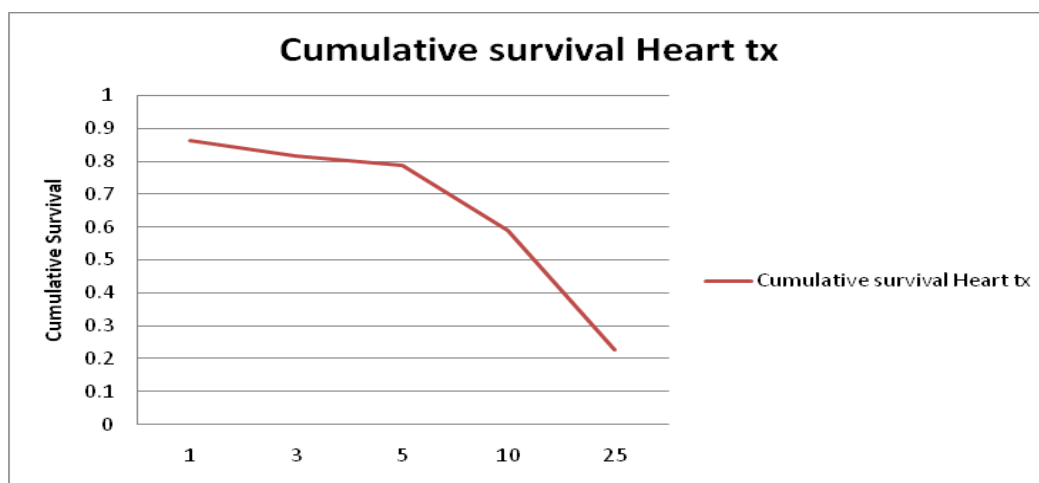


Figure 2: Cumulative Survival of Solitary Heart Transplant over 25 years.

The actuarial survival of the two groups over a 25 year period was then compared. (Figure 3) At the 10 year mark, actuarial survival for the combined group was comparable to the heart only transplant group with figures of 55% versus 59%.

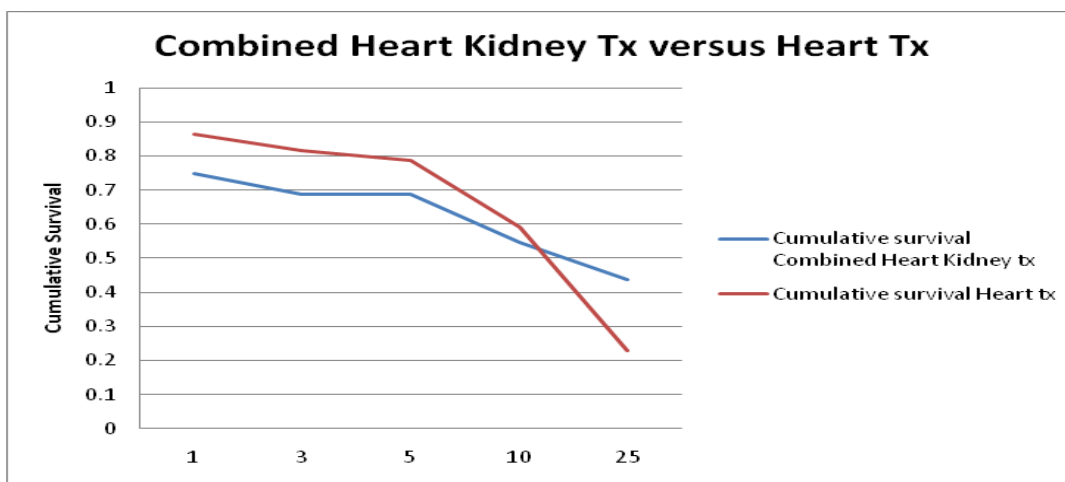


Figure 3: Combined Heart Kidney Transplant Cumulative Survival Versus Solitary Heart Transplant Cumulative Survival over 25 years.

The main causes of death were sepsis resulting in multisystem organ failure, cardiac arrest and malignancy. There was a low incidence of dual graft failure as the primary cause of death. Most patients after the first year post combined procedure had a relatively good graft longevity and function.

Discussion

The current study represents the longest single center experience of simultaneous combined heart kidney transplantation. It confirms and demonstrates that combined heart kidney transplantation has favourable short and long term outcomes for patients with end stage cardiac and renal failure especially when on renal replacement therapy at the time of transplantation which often is a contraindication in itself to solitary organ transplant.

The overwhelming majority of our patients were on renal replacement therapy at the time of their combined heart and kidney transplantation. Although there is conflicting analysis of registry data by Russo et al suggesting greater adverse outcomes of patients who underwent combined heart kidney transplantation whilst on renal replacement therapy in comparison to those not on renal replacement therapy with an EGFR of less than 30, our study showed markedly improved survival outcomes in 14 out of 16 of our patients or 87.5% of the cohort (Table 4). This emphasizes the superior outcomes for patients with concurrent end stage cardiac and renal failure requiring renal replacement therapy who undergoes combined cardiac and renal transplantation.

Table 4: Long Term Graft Function and Complications Post Transplantation with Survival Outcomes and Cause of Mortality

Patient	Renal Graft function- Creatinine mmol/l	Cardiac Graft function: Ejection fraction	Major Long term complications post transplantation	Minor Complications post transplantation	Graft survival	Patient survival	Cause of Death
1	100	50%	1. CMV gastritis/ esophagitis	Squamous Cell Skin Cancer	Both Functional	Alive	N/A
2	Graft failure- Rejection Back on HD	AMI-Cardiac graft failure	CMV pneumonitis, Recurrent VRE urosepsis	N/A	Both grafts failed	Deceased	Cardiac Arrest
3	159	42%	Allograft vasculopathy	N/A	Both Functional	Deceased	Cardiac Arrest
4	125	50%	Nil	N/A	Both Functional	Alive	N/A
5	120	60%	1. Recurrent infections: Staph, CMV, HSV 2. Aortic Dilatation: Bentall's CABG 04 3. Allograft Vasculopathy	N/A	Both Functional	Alive	N/A
6	130	60%	Allograft vasculopathy	Squamous Cell Skin Cancer/ Bowens disease	Cardiac Graft Failed	Deceased	Allograft vasculopathy
7	135	25%	1. Atrial Myxoma/ Atrial Thrombus 2. Subdural Haemorrhage	N/A	Both Functional	Alive	N/A
8	110	25%	Nil	N/A	Cardiac Graft Failed	Deceased	Multisystem organ failure in ICU post Tx
9	90	50%	SCC- excision required. Mandibular excision	HPT, Dyslipidemia, Gout, osteoporosis	Both Functional	Alive	N/A
10	77	50%	Malignancy - Non Lymphoproliferative/Disseminated adenocarcinoma CMV gastritis/ disseminated herpes zoster	N/A	Both Functional	Deceased	Malignancy - Non Lymphoproliferative malignancy
11	121	50%	Nil	Basal Cell Skin Cancer / Bowens disease	Both Functional	Alive	N/A
12	105	60%	Nil	N/A	Both functional	Alive	N/A
13	80	35%	P.E, Lymphoproliferative disorder(PTLD)	N/A	Both Functional	Deceased	Lymphoproliferative disorder
14	N/A	N/A	Sepsis	N/A	Both Functional	Deceased	Sepsis +multi-system organ failure
15	220	28%	Nil	N/A	Cardiac Graft Failed	Deceased	Graft failure
16	135	50%	Allograft Vasculopathy	Squamous Cell Skin Cancer	Both Functional	Alive	N/A

CMV: Cytomegalovirus, HSV: Herpes Simplex Virus, CABG: Coronary Artery Bypass Graft. HPT: Hypertension. Staph: Staphylococcus. ICU: Intensive Care Unit.

Our study showed that kidney allograft function in the setting of combined heart kidney transplantation remained relatively intact with 15 out of 16 patients experiencing no renal graft failure. Simultaneous graft failure leading to death was observed in 1 patient in our study. This lower incidence of renal rejection was also reported in several other studies^[12,13,29]. The overall rate of rejection was encouragingly low with the majority of patients experiencing more significant cardiac rejection episodes that responded to either intravenous pulse steroids with one patient requiring plasmapheresis. Why this immunological tolerance was observed in the donor kidney is potentially multi-factorial with more stringent monitoring for cardiac rejection and the previously proposed phenomena of immunogenic tolerance to the less antigenic organ in the context of combined transplantation^[29-36].

Most importantly given the 1,5,10, and 25 year actuarial survival of 75%, 69%, 55% and 43.7% respectively, combined heart kidney transplantation can be viewed as a viable option for patients with concurrent end stage cardiac and renal dysfunction^[37]. Our study correlates closely with various other single center studies (Table 5) that have also demonstrated excellent short and long term survival outcomes of combined heart kidney transplantation over significant time periods.

Table 5: Survival Rate and Duration of Follow Up of Combined Heart Kidney Transplantation in a Single Center.

Studies	1 year survival %	5 year survival %	Number of Patients	Duration of Follow Up
Raichlin et al ^[15]	83	83	12	10 years
Luckraz et al ^[19]	77	60	13	15 years
Vermes et al ^[16]	66	55	12	10 years
Trachiotis et al ^[12]	87	87	8	8 years
Leesera et al ^[17]	77	60	13	10 years
Ruzza et al ^[35]	90	70	30	Ruzza et al 35

The challenge to combined heart kidney transplantation is the rationality and ethical dilemma surrounding combined organ transplantation given the limitations and constraints surrounding donor organ availability. In most cases multiple organs from either a single or multiple donors will be transplanted into a single recipient, posing a significant burden on the already limited resources of the state-wide and national transplant service. The overall waitlist times for combined heart kidney transplantation with a mean of 12.1 months in our study offers further emphasizes that this is a viable option with acceptable waiting times for patients with dual heart and kidney failure.

Conclusion

In conclusion, the results of this study further emphasizes that combined heart kidney transplantation produces good short and long term outcomes for patients with end stage heart and kidney failure and especially patients with end stage heart failure on renal replacement therapy. These favourable survival outcomes and lower rates of organ rejection with combined transplantation has now been reproduced consistently from multiple international centers with different selection criteria, making combined heart kidney transplantation a viable and effective therapeutic option for patients with end stage cardiac and renal failure who would previously not have qualified for solitary organ transplantation.

Conflicts of Interest: No disclosures in the submission of this work.

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