Does cardiac reserve improve with renal transplantation?

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Introduction

The treatment modality that has consistently shown to improve cardiovascular disease morbidity and mortality in end stage renal disease (ESRD) is renal transplantation (RTx). Cardiac imaging studies have shown that left ventricular hypertrophy regresses with kidney transplantation. However, elucidation of the corresponding cardiac functional changes is still lacking.

Hypothesis

In the present study we tested the hypothesis that RTx improves peak cardiac power output (CPO_{max}) and cardiac reserve.

Methods

In this pilot prospective study, 6 asymptomatic, non-diabetic male patients (>18 years) with CKD (stages 4-5) underwent symptom-limited cardiopulmonary exercise testing (CPX) before and after RTx. CPO_{max} was determined non-invasively using standard CO_2 rebreathing techniques for measuring cardiac output. Cardiac reserve, $\Delta CPO\ (W) = CPO_{max} - CPO_{rest}$ was calculated. Comparison between study parameters before and after RTx was performed using paired sample t-test. A *P* value of <0.05 is considered significant. Results are presented as mean±SD.

Results

The patients had a mean age of 48.4 years. The median time to CPX testing post-transplantation was 5 months (range: 3 to 11 months). The changes in biochemical and CPX parameters are listed in Table 1. *All patients showed improvement in CPO_{max} and cardiac reserve.* The mean CPO_{max} improved by 19.1% following RTx (P=0.003). This resulted from the improvement in the pressure and volume generating capacities and the chronotropic reserve of the heart (Figure 1). There was no significant difference in the aerobic exercise capacity (VO_{2max}) and haemoglobin.

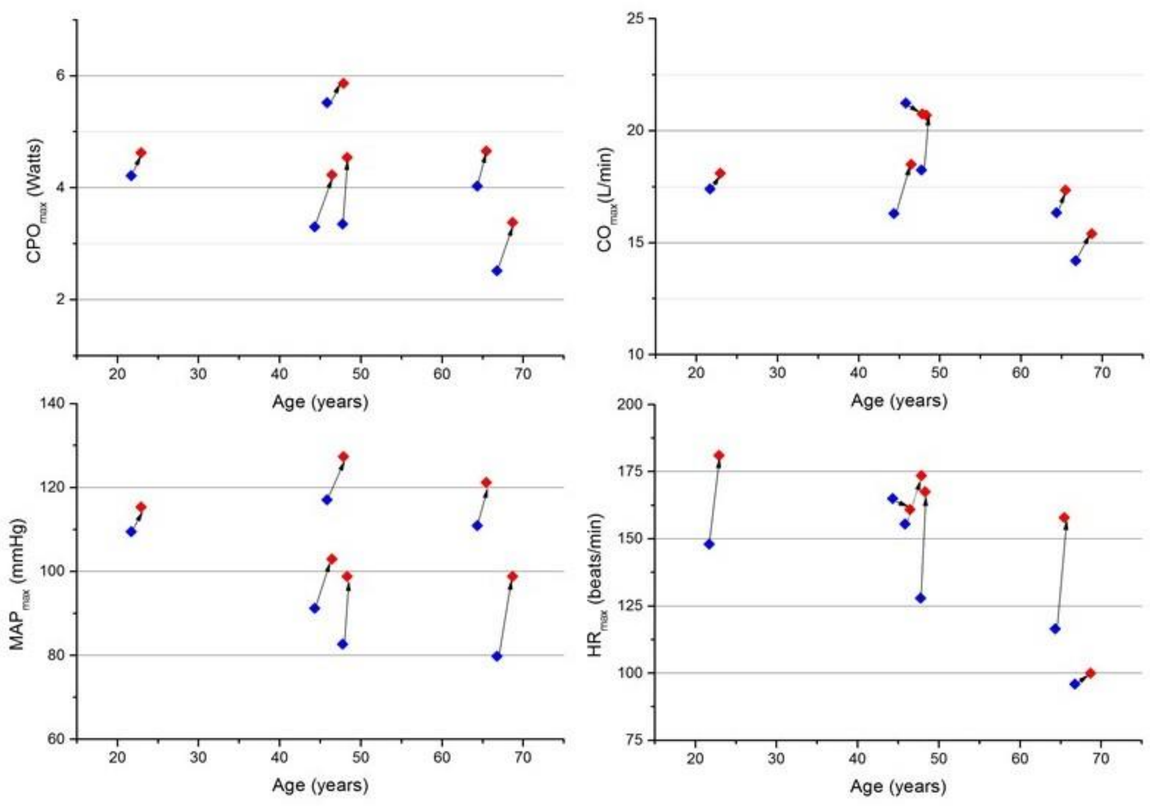

Fig 1: Peak cardiac power output (CPO_{max}) and other peak haemodynamic indices of CKD patients before (blue markers) and after (red markers) renal transplantation. CO_{max}: peak cardiac output, CPO_{max}: peak cardiac power output, HR_{max}: peak heart rate, MAP_{max}: peak mean arterial pressure.

Table 1: Biochemical and CPX parameters before and after kidney transplantation

	Pre	Post	P value
Biochemistry			
eGFR ($mL.min^{-1}$)	12.5±4.0	64.9±6.5	0.0004
Hb ($g.L^{-1}$)	114.7±16.7	127.8±10.5	0.12
Resting CPX parameters			
HR_{rest} (min^{-1})	68.3±13.3	78.7±15	0.10
MAP (mmHg)	87.1±10.9	90.5±4.3	0.54
VO_2 ($L.min^{-1}$)	0.34±0.10	0.34±0.09	0.98
CO ($L.min^{-1}$)	4.16±0.98	5.35±1.19	0.03
CPO_{rest} (W)	0.84±0.24	1.08±0.23	0.02
Peak CPX parameters			
RER	1.07±0.05	1.14±0.03	0.03
VO_{2max}($L.min^{-1}$)	2.44±0.60	2.62±0.45	0.21
HR_{max} (min^{-1})	134.8±26.1	156.8±29.1	0.04
MAP_{max} (mmHg)	98.5±15.9	110.8±12.3	0.001
CO_{max} ($L.min.^{-1}$)	17.29±2.37	18.47±2.05	0.04
CPO_{max} (W)	3.82±1.03	4.55±0.80	0.003
ΔCPO (W)	2.95±0.90	3.45±0.78	0.03

Hb: haemoglobin, eGFR: estimated glomerular filtration rate, CO: cardiac output, CPO_{rest}: resting cardiac power output, CPO_{max}: peak exercise cardiac power output, HR_{rest}: resting heart rate, HR_{max}: peak exercise heart rate, RER: respiratory exchange ratio at peak exercise, VO_{2rest}: resting O_2 consumption rate, VO_{2max}: peak O_2 consumption rate. P value is for paired sample t-test.

Conclusion: The present study demonstrates that RTx improves cardiac reserve and the central haemodynamics in CKD. Further large studies are needed to fully elucidate the underlying mechanism of such improvement. As only a small proportion of advanced CKD or ESRD patients receive kidney transplantation, mimicking the cardiac benefits of RTx through pharmacotherapy or through special dialysis strategies may benefit a broader CKD or ESRD population.

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